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April 15-18, 1984, Banff, Alberta

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Facility Siting and Routing 84

Energy and Environment

Proceedings of a Symposium held at
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Preface

These volumes contain the proceedings of, "Facility Siting and Routing 84", a symposium consisting of papers and workshops held at the Banff Centre, Banff, Alberta on April 15 - 18, 1984.

The anticipated large scale development of Canada's oil, gas and electrical energy resources over the next few decades will require that environmental factors be taken into account when facility siting and routing decisions are made, since it is at this stage that many potentially adverse impacts can be avoided or minimized.

The principal objective of the symposium was to provide an international forum for the exchange of state of the art information for the selection of environmentally appropriate routes and sites for facilities associated with land based oil and gas operations, and the generation and transmission of electrical energy in Canada.

The symposium's papers and workshops addressed key environmental issues which can be taken into account when sites and routes are selected for electrical generation and transmission and land-based oil and gas development. The symposium covered in detail the best environmental practice for the siting of thermal power plants and the routing of transmission lines. It also dealt with the environmental practice for the siting and routing of facilities associated with land-based oil and gas operations.

Session I papers - (Methods for Routing and Siting) give a broad overview of the state-of-the-art in Facility Siting and Routing in Canada and the United States. This session also examined important issues and experiences in siting, overland and marine routing.

Session II papers - (Elements of the process) dealt with the current methodology for data management in Siting and Routing. Siting and Routing case studies are included.

Session III papers - (Regulation, public interest and decision making) dealt with the regulation and administration of siting/routing exercises, public interest - participation, and decision-making.

Key factors and/or issues addresssed in the above three sessions provided the basis for the workshop discussions and decisions. A workshop summary is provided.

Environment Canada wishes to extend its appreciation to all the authors for their efforts in preparing and presenting the symposium papers. Keynote speeches were provided by Dr. R.W. Slater, Assistant Deputy Minister, Environment Canada, Mr. F.W. McDougall, Deputy Minister, Alberta Energy and Natural Resources, Mr. R. Reid, Vice-President Engineering and Operations, Trans-Canada Pipelines Ltd., Mr. Jacques Farmer, Associate Vice-Chairman, National Energy Board and the Honorable Thomas Berger.

The organization and running of Banff '84 involved the following people.

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Special thanks are also extended to the following:

C. Hardie, Director, Conference Services, Banff Centre, P. Duffy, Federal Environmental Assessment and Review Office, H. Gillespie and H. Sequeira, Environment Canada and Petro-Canada, M. Gewurz, C. Banwell and K. Rothwell, Environmental and Social Systems Analysts Ltd. (ESSA). Robert Everitt, Environmental and Social Systems Analysts Ltd. (ESSA).

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ENERGY FACILITY SITING AND ROUTING:
THE CANADIAN EXPERIENCE

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ABSTRACT

Since the war Canada has witnessed a dramatic increase in population accompanied by tremendous expansion in industrial and energy related development. The increased scale of major projects combined with increased public concern for the environment has lead to the requirement for an environmental impact assessment (EIA) of major projects. Initially EIA's were carried out too late to influence project location or design. As a result of criticism during the review process environmental concerns were integrated with engineering prefeasibility siting and routing studies.

The legal requirement for siting and routing studies is implicit in Canada. All jurisdictions recognize the value of these studies and some have issued generic guidelines. Many major proponents also recognize this implicit requirement and routinely conduct siting and routing studies.

Canadian siting and routing practice is on a par with that in the United States. Although a phased approach is generally used many studies do not make use of a clearly defined methodology which would help ensure a more competent comprehensive and intelligible analysis of the siting and routing problem.

Canadian practitioners have experimented with the entire range of techniques used in siting and routing. This has lead to the development of several schools of thought on the subject rather than to the general realization that no single technique, much less a single methodology, is appropriate to all circumstances.

What is required is an improved dialog between specialists and a much better understanding of the capabilities of existing techniques and how they are best applied to solving Canadian siting and routing problems.

INTRODUCTION

In the next 30 minutes I would like to briefly address three aspects of siting and routing practice in Canada. First its history and development, secondly its legal basis and the availability of guidelines and finally, problems associated with the use of methologies and techniques.

HISTORY AND DEVELOPMENT

Early Canadian man's energy budget was about 2000 kilo cal per day. This is equivalent to the amount of energy released by burning 0.25 kg of coal or, in terms we can all relate to, about three "Big Macs". Energy facility siting and routing and environmental impact were the furthest thing from his mind. While things did not change much for a long time, once they started to move the change in Canadian energy demand was dramatic.

The early Canadian pioneer growing a few crops and using animal energy to supplement his own, consumed about six times the energy of his predecessor. Around the turn of this century the energy requirements of our grandparents had increased another six fold. Today our demand for energy has increased yet another four times. The rate of increase has been almost exponential. We each require the equivalent of 450 "Big Macs" each and every day to meet our energy needs.

Our lives are becoming more and more complex, our needs greater and more varied. Since the war we have witnessed a dramatic increase in population accompanied by tremendous expansion in industrial development. We need more and more energy to provide the goods and perform the services we demand. Energy for transportation, to run our factories, our cities and heat our homes.

The more energy we need the further afield we must go to obtain it, the more diverse and numerous the sources we tap to provide it, the more extensive the networks we must devise to deliver it.

In the 50's, 60's and 70's Canadians witnessed major growth and development in the energy sector. The major discoveries of oil in the Leduc fields of Alberta in 1947 and early 1950's spurred the construction of the Inter Provincial Oil Pipeline to eastern Canada. As oil exploration continued more and more gas was discovered and the Trans Canada gas pipeline followed in the late 1950's. During the 50's and early 60's numerous small refineries were built in western Canada and Ontario, and over 100 thousand km of smaller gas distribution systems were routed throughout the country. During the 1970's pipeline development continued but at a slower pace, existing systems were looped and much refining capacity was consolidated in larger facilities. The 1970's was also the era of the energy mega project in Alberta when tar sands, Syncrude and Great Canadian Oil Sands verged on becoming household words.

Canada's appetite for electrical energy has followed suit. Over the last 3 decades our total installed generating capacity has increased 10 times. The combined capacity of Canadian hydroelectric dams has evolved from 8 to 50 thousand mega watts. Our conventional thermal generating facilities, now produce 30 thousand mega watts annually compared to one thousand in 1950. The Candu Nuclear System which first became operational in the early 1970's now has 9 units operating in Ontario, Quebec and the Maritimes, producing an additional 6000 mega watts. The distribution network accross the country is comprised of over 200,000 km of electrical transmission lines.

The increased scale of major projects such as these combined with increased public appreciation of and concern for the natural environment, resulted in an increasing number of conflicts between different resource uses and users. These conflicts lead in 1969 to the passage of NEPA in the United States, and the adoption in 1973, of the Environmental Assessment Review Process (EARP) in Canada. The provinces have also adopted similar processes over the last ten years.

The objective of the American Legislation and the Canadian process was similar: to ensure that environmental considerations were taken into account in the planning of developments. The vehicle proposed was the environmental impact assessment (EIA).

When thinking of the environmental implications of a project, we can ask 3 basic questions.

1) What are the anticipated environmental effects (and how can they be mitigated)?
2) Is there an alternative site/route which will minimize the negative effects?
3) Does society need this project?

Lets look at how environmental impact assessment as intially implemented and how routing and siting as originally carried out by engineers and economists has evolved to answer the first two of these questions.

This figure illustrates the critical path of a simplified development process. The four boxes represent the major steps in bringing a project from conception to operation, engineering prefeasibility, engineering design, construction and operation.

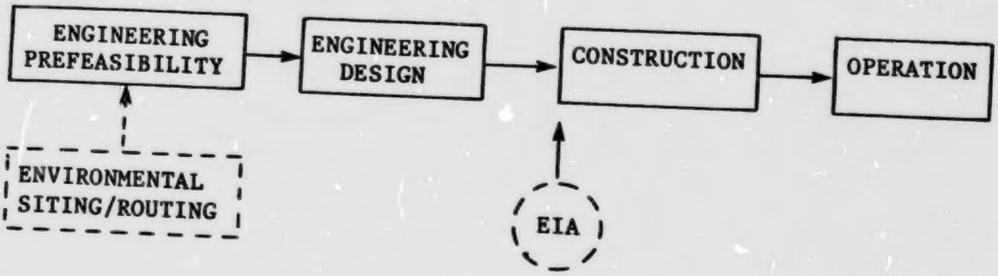


FIGURE 1 - SIMPLIFIED PROJECT DEVELOPMENT

Confronted with the necessity of carrying out an environmental impact assessment, the initial response of most proponents was to stick it where it would least perturb the development process. This generally meant that environmental concerns were considered after the proponent was fairly certain of what he was going to be doing and where he was going to do it.

As a result, early EIA's were carried out long after fundamental decisions as to project location and design characteristics had been made; decisions which, in effect, predetermine certain environmental impacts. Coming so late in the development process the EIA was rarely able to make significant changes in either location or design. Because considerable investment of time and money had already been made there was undoubtedly considerable pressure to make the best of a possibly less than desirable situation.

In 1973, Krieth reviewed a random selection of 200 of these impact statements and concluded they were rather ineffective in attaining their general objective of identifying impacts early enough in a project to permit modifications. He found that only 60 of the statements, listed any adverse environmental effects. In those which did, a total of 210 measures intended to reduce environmental effects were recommended. However, all were rejected.

This record of 0 out of 210 leads one to suspect the rationale behind, and use of,these statements. If all alternatives to proposed courses of action are eliminated why draw up a statement in the first place?

Despite this poor performance, those early EIA's which were competent, did answer our first question: What are the projects anticipated environmental effects (and how can they be mitigated)?

Review of these early EIA's by Government agencies and the public indicated that they did little to address the second fundamental question which was: Where could a given project be located to minimize its adverse environmental effects? The result was that projects proposed with no environmental evaluation of alternative sites or routes came in for increasing criticism during review. Proponents were pursuaded to integrate environmental concerns into siting and routing studies which historically had been the exclusive domaine of their engineers and costing experts. Naturally there was some resistance to the idea, and as many of you know it was not always an easy transition, but with time it has become a fairly well established practice.

To their credit the energy utilities were among the first to modify their approach to siting and routing. They were in the process of developing new energy sources, and expanding their delivery systems. They had the opportunity, the funds and now the need, to develop methods to integrate environmental concerns with their traditional siting and routing studies.

This was a very significant step in the evolution of environmental impact assessment. EIA had effectively evolved into a two stage process comprising an initial route/site selection and secondly, a project specific impact assessment.

It was now possible for environmental factors to be considered at a stage in project development when they could really influence project location and design. Early consideration of the environmental effects of alternative sites or routes permitted us to address our second question and provided the opportunity to avoid certain impacts completely rather than simply proposing mitigation after the fact.

Our third question as to society's need for a given project is one that we are only beginning to consider. Currently there is an attempt to address this question in the project justification section of an EIA. But neither proponents nor consultants are in the best position to speak for society as a whole. It is clearly a question best answered in government policy. In the absence of such policy the assumption we generally make, is that there is a project and it is needed by both proponent and society.

LEGAL BASIS AND GUIDELINES

Today siting and routing is done by the proponent as part of larger environmental assessment and approvals processes established by federal and provincial governments.

Table 1 is based on a review of existing federal and provincial regulations and guidelines addressing impact assessment as well as those which

TABLE 1: CANADIAN SITING AND ROUTING: REQUIREMENTS AND GUIDELINES[*]

	GOVERNMENT AUTHORITY	PROJECTS SUBJECT	REVIEWING AGENCY	SITING AND ROUTING GUIDELINES	
				SOURCE	TYPE
FEDERAL	•CABINET DECISION •ENERGY BD. ACT	•FEDERAL •INTER PROV.	FEARO NEB	ENV. CAN. NEB	GENERIC GENERIC
BRITISH COLUMBIA	UTIL. COMM. ACT	•ENERGY PROJ.	EMPR EPCC	EPCC ELUC BCH	PROJ. SPEC. PROJ. SPEC. PROJ. SPEC.
ALBERTA	•LAND SURFACE CONSERV. & RECLAM. ACT	•ENERGY PROJ.	ALTA. ENV. ERCB	ALTA. ENV. ALTA. POWER	GENERIC PROJ. SPEC.
SASKATCHEWAN	ENV. ASS. ACT	•SPECIFIC CRITERIA	SASK. DOE	SASK. DOE	GENERIC PROJ. SPEC.
MANITOBA	CABINET ORDER-IN-COUNCIL	•PROVINCIAL •PIPELINES	MEARA MONGCB	IPB MEARA MONGCB MANIT. H.	PROJ. SPEC. PROJ. SPEC. PROJ. SPEC. PROJ. SPEC.
ONTARIO	•ENV. ASS. ACT •ENERGY BD. ACT	•PROV. & MUN. •PIPELINES	ONT. MOE OEB	ONT. MOE OEB ONT. H. TCPL	GENERIC GENERIC GENERIC PROJ. SPEC.
QUEBEC	ENV. QUAL. ACT	•COMPREHENSIVE LIST	MENVIQ	MENVIQ CCE HQ	GENERIC GENERIC GENERIC
NEWFOUNDLAND LABRADOR	ENV. ASS. ACT	•COMPREHENSIVE LIST	NFLD. DOE	DOE N & L.H.	PROJ. SPEC. PROJ. SPEC.
NEW BRUNSWICK	GOVT. POLICY	•PROVINCIAL	N.B. DOE	N.B. DOE N.B. POWER	GENERIC[**] PROJ. SPEC.
PRINCE-EDWARD-ISLAND	•ORDER-IN-COUNCIL •ENV. PROT. ACT	•PROVINCIAL •UTILITIES	•DEPT. COMM. & CULT. AFF.	•MIN. COMM. & CULT. AFF. •PUB. UTIL. COMM.	PROJ. SPEC. PROJ. SPEC.
NOVA SCOTIA	ENV. PROT. ACT	•PROJECTS SCREENED	N.S. DOE	N.S. DOE	PROJ. SPEC.
TERRITORIES	CABINET DECISION	•FEDERAL	•FEARO •R.E.R.C. •GNWT (REN. RESC.)	ENV. CAN. GNWT	GENERIC PROJ. SPEC.

*: See Appendix I for abbreviations.
**: In press.

deal specifically with siting and routing. For each jurisdiction the table lists the authority indicating the requirement for a S/R study the type of project subject to the ordeal, the agency responsible for reviewing it, as well as the source and type of guidelines which are available.

The first point to be made is that in 8 out of 12 jurisdictions, the basis for requiring a S/R study is indicated in a legislative act which gives it the force of law. In the other instances, (federal, Manitoba, the Territories and New Brunswick) it is an administrative order or order-in-council. Usually the requirement occurs as a general statement indicating that alternatives to any given project must be described. Occasionally, as in Alberta and Newfoundland and Labrador, it may go as far as to require an analysis of the no project alternative as well as alternatives to and within the proposed project.

Based on a review of the existing regulations it was impossible to list specific projects requiring siting and routing studies for each jurisdiction. Most jurisdictions however list certain types of projects, such as government or major energy projects, and specifically exclude others. Some such as Newfoundland, Quebec and Saskatchewan have a comprehensive list of projects for which an EIA and possibly a route/site selection study is required. All jurisdictions use some form of screening procedure on a project by project basis to determine what type of studies will be required.

It has been reported that there is some uncertainty in Canada, as to whether a documented site selection study is required or voluntary. I would suggest that this question is largely of academic interest. It is clearly the governments intention that alternatives to potentially controveral projects be evaluated with respect to their relative environmental effects. In the event alternate locations are a reasonable possibility, the project proponent would be well advised to consult the appropriate government agencies and be prepared to undertake a siting/routing study prior to carrying out a site/route specific environmental assessment. This is the best possible way to demonstrate that environmental factors have been adequately considered and it will thereby decrease the probability that environmental approval would be withheld pending further studies.

In most areas of the country proponents of major projects do carry out both siting and routing studies, as well as an EIA even if they are specifically exempt.

In approximately half the jurisdictions listed in the table, siting and routing studies are reviewed and approved by the agency responsible for Environmental Impact Assessment. In some areas however, specific agencies have been established for the review of energy projects. Examples of this are: the Federal National Energy Board (NEB); British Columbia's Energy Project Coordinating Committee (E.P.C.C.); Alberta's Energy Resources Conservation Board (E.R.C.B.); Manitoba's Oil and Natural Gas Conservation Board (M.O.N.G.C.B.) and the Ontario Energy Board (O.E.B.).

Provincial and federal authorities issue two types of siting and routing guidelines. Generic guidelines are prepared in advance and are intended to apply to a class of project such as hydrocarbon facilities, electrical transmission lines or pipelines. Project specific guidelines are prepared in response to specific development proposals.

Generic guidelines are issued to give proponents of specific classes of projects an idea of what is expected in a routing/siting study and to avoid having to develop a new set of guidelines for each and every project proposed. Generic guidelines provide the basis for discussion between regulatory authorities and proponents regarding the details of the study.

As shown in the table, generic guidelines exist in jurisdictions where there has been the greatest amount of siting and routing activity. Alberta, Saskatchewan, Ontario and Quebec have issued generic guidelines for some types of projects. The NEB has published a guide to routing linear facilities and the federal government has commissioned several studies which have lead to the publication of guidelines for siting thermal generating plants, as well as the development of a process for the siting of hydrocarbon facilities on the Canadian Arctic Coast. Pat Kennedy will describe this process later this morning in session 1A.

Other jurisdictions have chosen to prepare project specific guidelines as required due to the relatively moderate number of projects involving siting and routing.

Guidelines issued across the country have several caracteristics in common whether they are generic or project specific. Typically they include a detailed list of siting or routing criteria intended to aid the proponent in locating the proposed facility. Second, virtually all recommend the use of a staged approach involving a regional screening, and an evaluation of candidate areas and potential sites prior to selecting a preferred site.

Generic and project specific guidelines vary greatly with respect to comprehensiveness and detail. Among the most explicit are those issued by Alberta and Quebec which describe and illustrate a staged approach to siting and routing. Both provinces go further in that they recognize the availability of numerous techniques which can be used in the screening and evaluation process. Quite reasonably they do not advocate the use of any specific technique.

METHODOLOGIES AND TECHNIQUES

In the few minutes that remain, let's look at the development of siting and routing methodologies and techniques in Canada and some of the areas in which there are current problems and a need for future effort.

Following the lead of the United States and Great Britain, Canadian siting and routing practice has developed rapidly over the last 10 years. Granted we do not have the breadth and depth of practical experience but we have been able to short-cut the process of developing a siting and routing philosophy from scratch.

While legal requirements differ, current Canadian site/route selection practice is on a par with the state of the art south of the border sharing most of the same qualities and failings.

As in the USA, the spectrum of siting and routing practice in Canada ranges from the very simple intuitive methodoly to extremely complex mathematical approaches. Although the direct site nomination approach is commonly used for certain projects with very specific siting requirements, the majority of Canadian authorities, proponents and consultants favor and use what is commonly referred to as a phased site selection process.

Typically, the process starts with a broad geographical region and progressively narrows it down in three phases. The first phase is a regional screening to exclude/or include large areas from/or for further consideration. The second is the identification of alternate sites or corridors using more detailed criteria. The final phase is an evaluation and comparison of alternatives which leads to the selection of the optimal site/route.

Now, as we all know, siting and routing is not as simple as all that, even in Canada. In fact, it is useful to remember that there are a number of features that make it particularly complex. Among these are the need to:

1) Deal with large areas/numbers of potential sites/routes;
2) Consider/rationalize/optimize several factors (biophysical, socio-economic, economic, technical);
3) Deal with a variety of disciplines and interest groups;
4) Deal with intangibles such as esthetics, psychological and moral considerations;
5) Measure the degree or magnitude of effects;
6) Evaluate the relative importance (significance) of effects;
7) Produce a logical, comprehensive competent and intelligible document.

This brings us to the problem of approach or methodology used in many siting and routing studies.

Because of its inherent complexity, the typical siting and routing study requires a detailed and formal approach. An example of the type of detailed methodology, required by an approach we use to site linear corridors (Figure 2). As in the simplest case, it includes the basic phases of regional screening, identification of alternatives, alternative evaluation and site selection. Each of these phases is comprised of a series of components steps or tasks which lead to the subsequent phase.

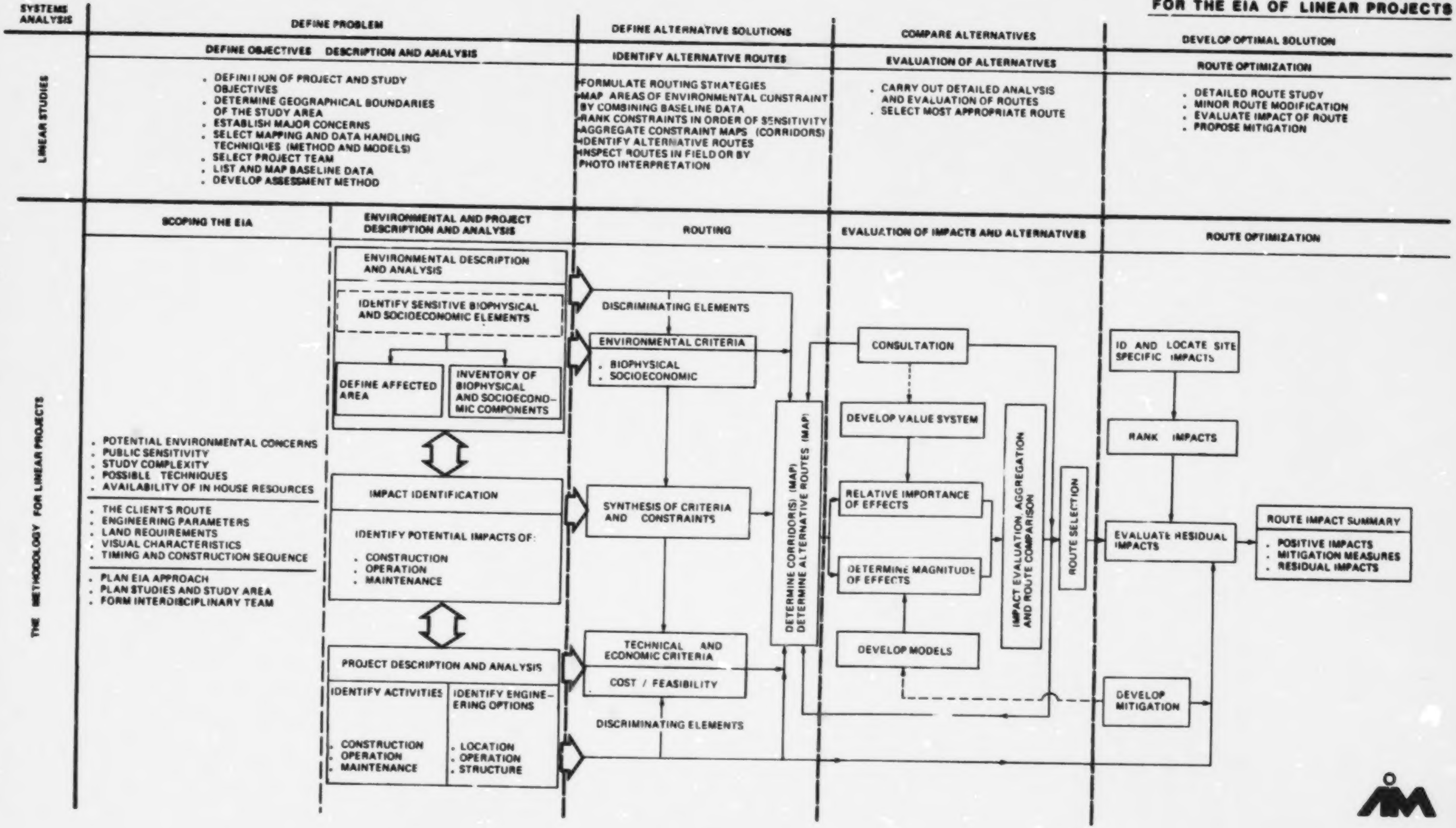
The methodology identifies the components of each phase and the tasks to be carried out. It illustrates the sequential and functional interrelationship between components ensuring a logical approach and the appropriate application of techniques used to achieve the goals of each phase.

Despite the obvious advantages of this type of methodology and the fact that it is being used by some Canadian proponents and consultants, the majority of Canadian siting and routing studies adopt a less rigorous approach. This is partly due to the fact that siting and routing is a relatively immature field of endeavor which has yet to develop a solid procedural basis. In addition, however, it is due to the background and training of the majority of siting and routing practitioners who have come from the natural sciences and are frequently unaccustomed to thinking in terms of flow diagrams, systems, and critical path analysis.

What ever the reason, it is clearly an approach that should be more widely practiced. One that can facilitate report preparation by the study team, and help ensure a more comprehensive, competent and understandable analysis of the siting and routing problem. Allison Massa will be going into more detail as to the components and advantages of detailed siting methodologies.

FIGURE 2

A METHODOLOGY FOR THE EIA OF LINEAR PROJECTS


SYSTEMS ANALYSIS
DEFINE PROBLEM
DEFINE ALTERNATIVE SOLUTIONS
COMPARE ALTERNATIVES
DEVELOP OPTIMAL SOLUTION
LINEAR STUDIES
DEFINE OBJECTIVES
DESCRIPTION AND ANALYSIS
. DEFINITION OF PROJECT AND STUDY OBJECTIVES
. DETERMINE GEOGRAPHICAL BOUNDARIES OF THE STUDY AREA
. ESTABLISH MAJOR CONCERNS
. SELECT MAPPING AND DATA HANDLING TECHNIQUES (METHOD AND MODELS)
. SELECT PROJECT TEAM
. LIST AND MAP BASELINE DATA
. DEVELOP ASSESSMENT METHOD
IDENTIFY ALTERNATIVE ROUTES
FORMULATE ROUTING STRATEGIES
MAP AREAS OF ENVIRONMENTAL CONSTRAINT BY COMBINING BASELINE DATA
RANK CONSTRAINTS IN ORDER OF SENSITIVITY
AGGREGATE CONSTRAINT MAPS (CORRIDORS)
IDENTIFY ALTERNATIVE ROUTES
INSPECT ROUTES IN FIELD OR BY PHOTO INTERPRETATION
EVALUATION OF ALTERNATIVES
. CARRY OUT DETAILED ANALYSIS AND EVALUATION OF ROUTES
. SELECT MOST APPROPRIATE ROUTE
ROUTE OPTIMIZATION
. DETAILED ROUTE STUDY
. MINOR ROUTE MODIFICATION
. EVALUATE IMPACT OF ROUTE
. PROPOSE MITIGATION
THE METHODOLOGY FOR LINEAR PROJECTS
SCOPING THE EIA
ENVIRONMENTAL AND PROJECT DESCRIPTION AND ANALYSIS
ROUTING
EVALUATION OF IMPACTS AND ALTERNATIVES
ROUTE OPTIMIZATION
. POTENTIAL ENVIRONMENTAL CONCERNS
. PUBLIC SENSITIVITY
. STUDY COMPLEXITY
. POSSIBLE TECHNIQUES
. AVAILABILITY OF IN HOUSE RESOURCES
. THE CLIENT'S ROUTE
. ENGINEERING PARAMETERS
. LAND REQUIREMENTS
. VISUAL CHARACTERISTICS
. TIMING AND CONSTRUCTION SEQUENCE
. PLAN EIA APPROACH
. PLAN STUDIES AND STUDY AREA
. FORM INTERDISCIPLINARY TEAM
ENVIRONMENTAL DESCRIPTION AND ANALYSIS
IDENTIFY SENSITIVE BIOPHYSICAL AND SOCIOECONOMIC ELEMENTS
DEFINE AFFECTED AREA
INVENTORY OF BIOPHYSICAL AND SOCIOECONOMIC COMPONENTS
IMPACT IDENTIFICATION
IDENTIFY POTENTIAL IMPACTS OF:
. CONSTRUCTION
. OPERATION
. MAINTENANCE
PROJECT DESCRIPTION AND ANALYSIS
IDENTIFY ACTIVITIES
. CONSTRUCTION
. OPERATION
. MAINTENANCE
IDENTIFY ENGINEERING OPTIONS
. LOCATION
. OPERATION
. STRUCTURE
DISCRIMINATING ELEMENTS
ENVIRONMENTAL CRITERIA
. BIOPHYSICAL
. SOCIOECONOMIC
SYNTHESIS OF CRITERIA AND CONSTRAINTS
TECHNICAL AND ECONOMIC CRITERIA
COST / FEASIBILITY
DISCRIMINATING ELEMENTS
DETERMINE CORRIDOR(S) (MAP)
DETERMINE ALTERNATIVE ROUTES (MAP)
CONSULTATION
DEVELOP VALUE SYSTEM
RELATIVE IMPORTANCE OF EFFECTS
DETERMINE MAGNITUDE OF EFFECTS
DEVELOP MODELS
IMPACT EVALUATION, AGGREGATION AND ROUTE COMPARISON
ROUTE SELECTION
ID AND LOCATE SITE SPECIFIC IMPACTS
RANK IMPACTS
EVALUATE RESIDUAL IMPACTS
DEVELOP MITIGATION
ROUTE IMPACT SUMMARY
. POSITIVE IMPACTS
. MITIGATION MEASURES
. RESIDUAL IMPACTS

A second general problem area in siting and routing has to do with the selection and use of appropriate techniques.

There are many techniques which have been used in siting and routing studies. These include all those listed in table 2 and undoubtedly a few more which I have missed.

TABLE 2

TECHNIQUES USED FOR THE PRINCIPAL TASKS INVOLVED IN SITING AND ROUTING STUDIES

SITING AND ROUTING	
TASK	TECHNIQUES
IDENTIFICATION	•CHECK LIST •NETWORK ANALYSIS •SIMPLE MATRICES •STEEPPED MATRICES •CONSTRAINT MAPPING •OVERLAY TECHNIQUE •NOMINAL GROUP •DELPHI
MEASUREMENT/PREDICTION	•BIOPHYSICAL MEASUREMENT •PHYSICAL SIMULATION •MATH MODELLING •SCALING
EVALUATION	•DISPLAY •WEIGHTING •AGGREGATION •NOMINAL GROUP •DELPHI •DECISION ANALYSIS •SENSITIVITY ANALYSIS
COMMUNICATION	•SCOPING •PUBLIC CONSULTATION •EIS •AGGREGATION •NOMINAL GROUP •DELPHI

None of these techniques can perform all the tasks required of a Siting/ Routing methodology. Each has a specific role to play and each can be classified according to its function within a methodology. There are techniques to: IDENTIFY project alternatives project characteristics and environmental parameters; MEASURE and predict magnitudes of environmental effects; EVALUATE the significance of effects; and others to facilitate COMMUNICATION.

Several, criteria should be taken into consideration when selecting a technique for a given task these include consistency, adaptability, data requirements and social and political acceptability.

In view of these different criteria it is clear that selection of the best technique will involve a trade off and that the one finally selected may not be best in all respects, or in all situations. For this reason no single technique is likely to best perform a given task under all circumstances.

Despite this knowledge most siting/routing studies show little evidence that the pros and cons of using particular techniques have been considered objectively. In fact many practitioners admit a bias in favor of one technique or another. There appear to exist several schools of thought on the subject of appropriate techniques each advocating a specific approach while ignoring on dismissing the possibilities offered by others.

This state of affairs is not surprising in view of the fact that much of the literature over the past 10 years has prescribed the development of new integrated methodologies or the use of a specific technique to solve our siting/routing problems.

It now appears highly improbable that a single technique much less a single methodology will be found appropriate to all circumstances. What is required is a much better understanding of the capabilities of existing techniques and how they are best applied to solving siting and routing problems.

Sure, siting and routing has come a long way since EARP. But it is still immature field of endeavor and unfortunately its practitioners may be somewhat like the drunk who, having lost his keys, spent the night looking only under a lamp post where there was light.

We must each make an effort to look beyond our personal circle of light, to exchange ideas and establish a continuing dialog with other practitioners and to begin building on past experience by endorsing what is good and improving where we can. This conference is a step in the right direction and I am certain you will have both a productive and pleasant stay here at the Banff Center.

APPENDIX 1

EXPLANATION OF ABBREVIATIONS

CCE	Conseil consultatif de l'environnement
ELUC	Environmental Land Use Committee
EMPR	Energy Mines Petroleum Resources
EPCC	Energy Project Coordinating Committee
ERCB	Energy Resources Conservations Board
FEARO	Federal Environmental Assessment and Review Office
GNWT	Government North West Territories
IPB	Inter-departmental Planning Board
MEARA	Manitoba Environmental Assessment Review Agency
MENVIQ	Ministère de l'Environnement du Québec
MOE	Ministry of the Environment
MONGCB	Manitoba Oil and Natural Gas Control Board
NEB	National Energy Board
OEB	Ontario Energy Board
RERC	Regional Environmental Review Committee
TCPL	TransCanada PipeLines Inc.

ENERGY FACILITY SITING AND ROUTING -- THE AMERICAN SCENE

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EDAW, inc., San Francisco, California

ABSTRACT

The paper overviews the development of a process for systematically and comprehensively siting and routing energy facilities in America. A five-step process is presented: project goal formulation; project definition; identification of project-environmental relationships; site screening; and, lastly site evaluation. The core of the process, which has universal application to energy developments, is the progressive narrowing of the area of search while the detail of the investigation increases. The relationship of the process to federal review procedures and the extent and success of its use are examined nationally and regionally. The major reasons for project failure are discussed and needed improvements and research activities are identified.

INTRODUCTION

The art and science of energy facility siting and routing is now somewhat over fifteen years old, predating passage of the National Environmental Policy Act by a short time. During that time, major strides have been taken towards developing a formal and widely accepted process for the incorporation and integration of system planning and environmental interests in facility location decisions. This paper presents an overview of that process and the extent and effectiveness of its use in America.

Background of Energy Facility Siting in America

Particular emphasis has been placed on the identification and mitigation of physical and biological environmental impacts. It was concern over the impact of power transmission lines on the rural landscape that first stimulated the interest of planners in Great Britain in developing route-selection and design guidelines over 25 years ago. A similar concern with the environmental effects of uncontrolled growth began to gather momentum in the United States in the early 1960's. During these years, two major energy-related conflicts attracted wide attention. On the West Coast, the fight involved the proposed nuclear power plant at Bodega Head, forty miles north of San Francisco, centering on the issues of the safety of such a plant located so close to the San Andreas earthquake fault and on the impact of the plant on the beauty of a site whose purchase had already been authorized for a state park. On the East Coast, the controversy surrounded the proposed construction on the Cornwall hydroelectric plant at Storm King Mountain on the Hudson River, a similar distance north of New York City.

In the case of Bodega Head, after an extremely confusing series of arguments on both sides, the sponsor, Pacific Gas and Electric Company, withdrew its proposal when it was found during detailed geologic investigations in 1964, that the site was located on an active subsidiary of the San Andreas Fault.

The Storm King protest originally centered on visual impacts but later expanded to incorporate various concerns which, interestingly, also included possible seismic hazards and effects on a proposed state park on the site. In this case, the Federal Power Commission granted a license in the spring of 1965 but was promptly taken to court by the opposition. The Second Circuit Court remanded the license with the judgment that the hearing record was inadequate, that aesthetic, conservation and recreational interests had to be protected in power development cases, and that a conservation organization could sue to protect the public interest under the Federal Power Act. The project was to go through many years of litigation and complete redesign from an above-ground to an underground powerhouse, before finally being granted a license. Construction began in early 1974, only to be halted by a new challenge regarding impacts on fish life a few months later.

These two projects are of particular importance in the development of site-selection procedures. They clearly demonstrated the need for a more careful selection of sites for energy projects and because of the 1965 Circuit Court's decision which encouraged citizen's suits in such cases, they provided clear warning that, henceforth siting decisions not made in full public view would risk delay or failure. In addition, this decision helped to lay the basis for passage of NEPA in 1969.

While the history of these cases is important, examination of subsequent events is instructive and salutory. NEPA was intended to ensure careful attention to environmental quality but to do so with efficiency by providing standard procedures for recognizing all affected interests. In fact, the existence of NEPA has guaranteed neither improved decision-making nor reduced delay.

The reason is largely that NEPA introduced a requirement for environmental assessment of a project too late in the processof its planning. Indeed, in the early years after its enactment, the required Environmental Impact Statement too often was prepared after the fact, that is, after decisions critical to the nature of the project had been made. The subject of NEPA and recent changes in its application will be returned to later in this paper.

At about the same time that environmental interests were gathering strength in the late 1960's to push for passage of federal environmental protection legislation, another trend was taking shape. Certain energy companies, recognizing the costly project delays and cancellations experienced across the country, saw the need to conduct their facility planning and siting activities in a less haphazard manner. Planners and, particularly, landscape architects began increasingly to be drawn into the process of selection sites for energy and other large projects as a natural outgrowth of those aspects of both professions that deal with large-scale regional resource and environmental analysis.

One of the first power companies in this area was Pacific Gas and Electric Company whose service area covers northern California. PG&E owned a tract of very sensitive coastal land south of San Francisco where it was contemplating construction of a nuclear power plant and was anxious to avoid the problems it had experienced at Bodega Head. While the general location had already been determined, the evaluation of the large site and alternative conceptual site plans and the computerized route selection for the transmission lines through the neighboring mountains were pioneering studies. Another pioneering company was Northern States Power whose executives later stated that use of an open and comprehensive siting process had allowed the company to complete a power plant and transmission system on time for the first time in a decade. From such studies, evolved a series of siting and route selection projects and research studies by EDAW and others that have continued to advance the state of the art and the recognition of its value.

These site-selection studies have continued to demonstrate that adversarial proceedings and other delays to project sponsors can be minimized, environmental and community impacts can be significantly reduced, and the project's technical requirements can often be met more closely than through a less rigorous and comprehensive process. Acceptence of the wisdom of conducting a site search openly and thoroughly is, however, by no means universal yet in the United States, either for energy- related or other major projects. Quite recently, for example, the authors were contracted to assist a power company with the routing of a major transmission line in Hawaii. This project had been the subject of repeated, intense and costly controversy for many years. Routing proposals had been introduced without prior consultation with potentially affected residents and interest groups and without a well-documented presentation of the planning considerations. The company was pleasantly surprised to find that on its third attempt, acceptance and licensing were achieved with relative ease. This company is now committed to a new mode of operation.

In light of such experiences and observations, some three years ago, the need for a book presenting planners, government officials, industrial and energy companies, and conservation organizations with a guide to major facility siting and routing was recognized. The intention of the authors in Siting of Major Facilities is to describe a universal process that bridges and balances the interests of project proponents, the technical requirements of facility designers, the environmental protection required by law, and public values of potentially affected communities and citizens.

THE COMPREHENSIVE SITING PROCESS

The open and comprehensive process for making defensible and successful siting and routing decisions offered by the book represents, with necessary project- and region-specific modifications, the state of the art in America today. The following brief description of the process may perhaps provide a useful framework for the siting, routing and research studies to be presented at Facility Siting and Routing '84 , all of which address means of eliminating potential causes of project failure or adverse impacts in greater or lesser detail.

The premise of the book is that project failure results principally from one or more of the following: poor definition of project needs, goals and characteristics; lack of, or ineffective, public involvement; and failure to follow a clearly traceable siting process. Each of these points is addressed in the comprehensive and systematic process summarized in the following diagram. A common and consistent vocabulary of siting terms is presented and each step in the overall process shown in the following diagram is discussed and illustrated in a separate chapter. The five principal steps are:

- Project goal formulation
- Definition of the technical characteristics and requirements of the project
- Identification of required and potential relationships between the project and the environment
- Identification and screening of candidate areas
- Evaluation of candidate sites

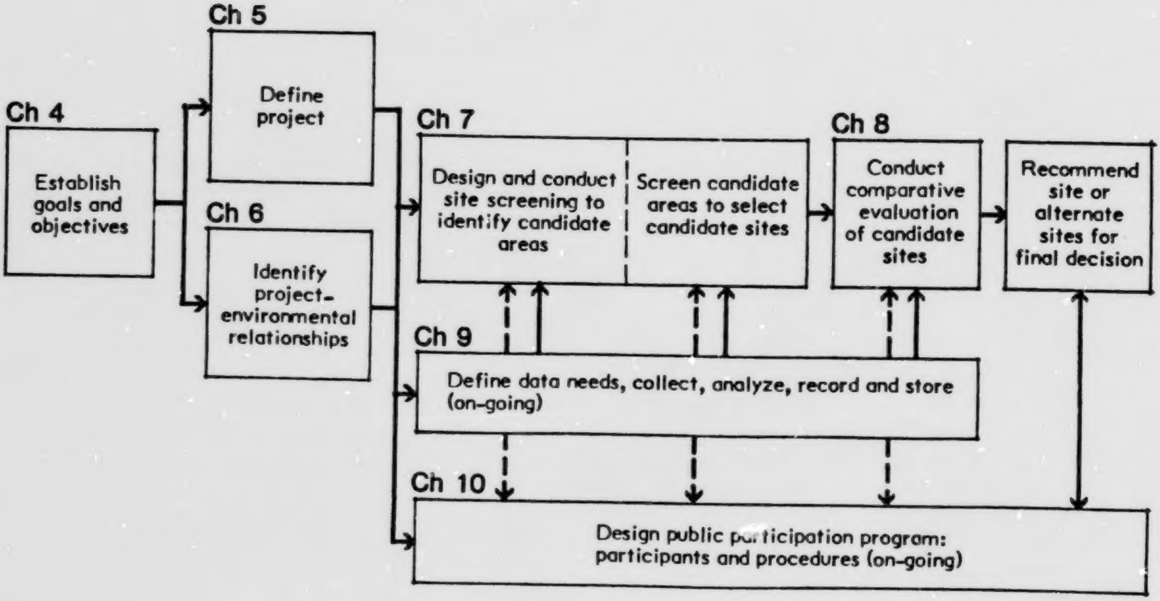

Ch 4
Establish goals and objectives
Ch 5
Define project
Ch 6
Identify project-environmental relationships
Ch 7
Design and conduct site screening to identify candidate areas
Screen candidate areas to select candidate sites
Ch 8
Conduct comparative evaluation of candidate sites
Recommend site or alternate sites for final decision
Ch 9
Define data needs, collect, analyze, record and store (on-going)
Ch 10
Design public participation program: participants and procedures (on-going)

Figure 1. Overall Siting Process

Project Goals and Objectives

The first step emphasizes the importance correct identification of the need for the particular type of project by the sponsor in addition to formulating the objectives to be met by the project. While it may appear rather an obvious point, inadequate or inaccurate assessment of project need has severely delayed a number of projects. One of these, for example, was a proposed fossil-fueled power plant for the State of California for which the authors undertook a statewide site search. This project was canceled at the conclusion of the study in part because power needs were found to have been incorrectly projected and in part because of a political decision to emphasize conservation and alternative energy sources rather the use of fossil fuels.

Also part of the critical foundation of a successful project, project objectives need to be stated as comprehensively as possible to represent both the interests of the project sponsor and those of the public as expressed in legal requirements and commonly accepted standards. Objectives provide the basis for determining the broad categories of data to be collected and analyzed.

Project Definition

This next step involves the description of the proposed project in as much detail as possible to assist both project planners and the participating agency, technical and lay participants in understanding its requirements and potential impacts. The definition should be presented in qualitative and quantitative terms which are as understandable and graphic as possible.

Often at this stage, the nature of the project may not be precisely definable since refinement or selection among alternative technologies may depend upon allowable impacts and environmental resources of the selected location. It is,however, essential to distinguish "must have" features and environmental requirements from those that are optional.

Project-Environmental Relationships

This step requires the systematic identification of all of the requirements that the project will have of the environment -- the needed volume and quality of water, for example, and all of its potential impacts upon the environment. These requirements and impacts are expressed as technical, legal, and commonly accepted standards that are quantified wherever possible. This step also is the time to identify those aspects of the project's effects where standards or relative importance values are less clear. Interaction with technical and citizen participants can then focus on the resolution of such issues as the project progresses.

Site Screening

The core of the siting process involves the successive narrowing of an appropriately identified region, state or province or other area of search. As candidate areas and candidate sites are selected and evaluated, the analysis becomes progressively more detailed, using selection criteria derived from the previously established project objectives and environmental analysis. The following diagrams illustrate this narrowing process for two power plant siting studies, one at the level of an entire state, the other for a much smaller region.

Site-selection criteria are keyed to data categories, or factors. Some data factors may be treated as exclusion factors whose presence in an area results in its elimination from further consideration. The remaining factors are termed evaluation factors, representing potential opportunities or constraints. A composite map of constraint factors further narrows the search to broadly suitable candidate areas by eliminating areas exhibiting major conflicts. In some site-selection studies, it may be desirable to weight constraint factors based upon their relative importance and magnitude prior to constructing the composite map.

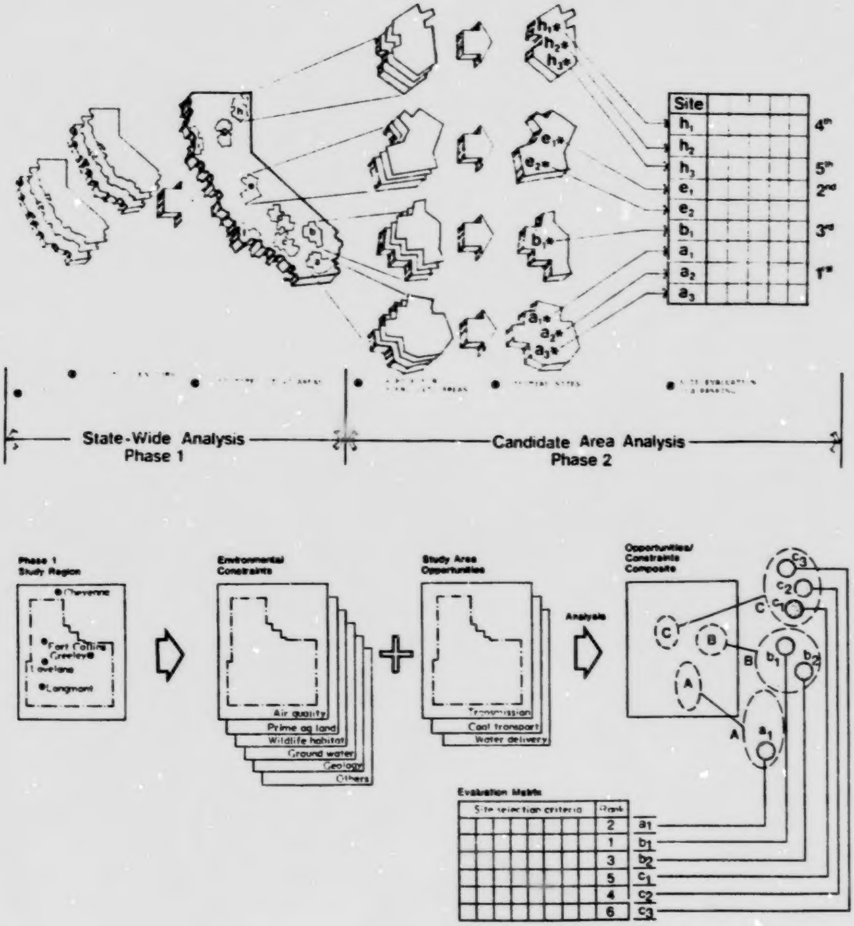

h_1
h_2
h_3
e_1
e_2
b_1
a_1
a_2
a_3
Site
h_1
h_2
h_3
e_1
e_2
b_1
a_1
a_2
a_3
4th
5th
2nd
3rd
1st
State-Wide Analysis
Phase 1
Candidate Area Analysis
Phase 2
Phase 1
Study Region
Cheyenne
Fort Collins
Greeley
Loveland
Longmont
Environmental
Constraints
Air quality
Prime ag land
Wildlife habitat
Ground water
Geology
Others
Study Area
Opportunities
Transmission
Coal transport
Water delivery
Analysis
Opportunities/
Constraints
Composite
C
B
A
c_3
c_2
c_1
b_1
b_2
a_1
Evaluation Matrix
Site selection criteria
Rank
2
1
3
5
4
6
a_1
b_1
b_2
c_1
c_2
c_3

Figure 2. Examples of Site Screening

Site Evaluation

Once the candidate areas have been screened and candidate sites have been identified in the selected area, a conceptual site plan is prepared and adjusted to fit each site to permit comparative evaluation. At this stage a more refined set of evaluation factors may be required, based on more specific knowledge of local conditions and planning issues. Usually, there will also be a change or expansion of the advisory committee menbership at this stage to include local citizens and officials as well as technical and agency representatives.

In the final stage, special attention will be given to the site planning and design details and performance standards to mitigate the unavoidable impacts of developing the preferred site or candidate sites.

Other Key Characteristics of the Process

The process involves the handling of large amounts of often complex data, requiring particular emphasis on good graphic presentation to aid the recording, retrieval, manipulation and communication of findings. Throughout the book, as well as in a separate chapter devoted to data analysis, various impact evaluation techniques are presented and compared. These include techniques for handling single evaluation factors, such as model construction, photo simulation and mapping of visual impacts, and techniques for achieving ratings or weighted rankings based on the full range of evaluation factors.

Special consideration is given to alternative graphic presentation methods for communicating information clearly to reviewing agencies and citizem study participants. Techniques for successfully involving the public in siting studies, including committees, workshops, surveys, and media communications are also explored.

The process described in terms of siting relatively footloose facilities is, being logical and universal, generally applicable to all energy developments. For mining and hydropower developments for which the candidate area or alternative candidate sites are already determined, the process begins part way through. For linear facilities such as power transmission lines and gas pipelines, a variety of techniques are described for selective use, depending on the extent of the study area and its complexity.

THE PROCESS AND ENVIRONMENTAL REGULATION

In recent years, the conduct and documentation of both site selection and legally required environmental reviews have become more closely tied together, and appropriately so. In the case of certain projects, power transmission lines, for example, the route selection is often now undertaken as an integral part of preparing the Environmental Impact Statement. The preliminary project description and environmental setting documentation can be prepared simultaneously for both purposes. In the case of very large and complex facilities, however, particularly those involving a very extensive area of search or whose project characteristics may change in response to the selected site, the EIS must still follow the site selection. However, if the process has been well-conducted, the EIS and licensing may proceed smoothly.

In either case, the processes have been of mutual benefit to eachother. First, the requirement of NEPA that alternatives to the project must be identified and examined has pressured some project sponsors to look more closely at siting than they otherwise might have done.

Secondly, by going through the recommended steps of the siting process, some projects may be significantly rethought or even abandoned early on, thereby avoiding not only the effort of full federal environmental document but also the cost of almost inevitable litigation. Early in a study of a proposed hydropower project conducted in Idaho, the authors were able to identify such severe potential impacts and through contacts with all major interest groups determine such well-organized opposition that the sponsor accepted the recommendation to cancel the project.

The concept of incorporating public interests in the early stages of siting and other approaches to ensuring streamlined planning, processing and licensing now have parallels in federal environmental review proceedures. In 1979, the Environmental Protection Agency made it mandatory to conduct a "scoping" effort to acquaint potentially affected interests with the project and identify probable issues at the outset of the EIS process. Scoping at the federal level and as now also required in many states will be addressed in other papers. "Environmental mediation" is another concept aimed at identification identification and mitigation of impacts in cooperation with those potentially affected. Such changes are not the direct result of the development and refinement of the siting process. Rather, like the siting process itself but of more recent origin, they arose in response to the concern of the public and of industrial and energy project sponsors in the late 1970's that environmental reviews had become too long and too costly and were impeding needed economic growth.

The charges of "environmental elitism", as Bernard Frieden described this concern in 1979, have died down in the aftermath of such experiences as Love Canal and Three Mile Island and amid such continuing controversies as the effort to license the Diablo Canyon nuclear power plant. However, the streamlining that they acheived have ongoing benefits.

Finally, the experience with siting studies and environmental review since 1970 has built up a store of standard siting, impact measurement and impact mitigation procedures. These now contribute to streamlining the process and have led to a generally better informed public, helping to ensure better projects. This is a generalization, however, true only when discussing the country as a whole and comparing the situation today compared with that of the late 1960's. Significant impacts remain to be dealt with effectively and new ones are coming to light. Moreover, the consciousness of sponsors and public agencies vary significantly from region to region, as do public attitudes. The outlook for the future and needs for research and regulatory changes will be discussed in the following section.

OUTLOOK FOR THE FUTURE

Future Constraints

In a recent study undertaken for the Electric Power Research Institute (EPRI), a representative sample of power companies in each of the regions into which the United States is divided by EPRI were asked to identify the most severe or most frquent constraints to transmission line routing encountered over the past five years. The same companies were then asked to name those constraints they anticipate will occur most frequently or pose thje most serious obstacles in their routing activities between now and 1995. The objective of the study was to assist EPRI in targeting transmission line routing research topics.

The responses, based on recent experience, obsevation of trends and the future power line corridors projected by the company and the researchers, provide some insights that may be helpful to Canadian planners. In summary (discounting some of the finer regional distinctions), it is reasonable to anticipate that the following constraints will be most troublesome:

- o Constraints that may be described as "technological" — health, safety and audible noise, etc. into which extensive research is already ongoing;
- o The increasing scarcity of remote and suitable land;
- o Incompatibility with specific land uses, including large scale intensive agriculture, urban land uses of all kinds, and designated natural areas;
- o Visual impacts, both short and long range; and
- o Lack of coordination with local land use policies and among federal agencies with land use policy or jurisdictional responsibility.

It is interesting that specific mention of biological, topographic or other physical constraints was rare compared to these more generic problems. This appears to indicate that the need to identify and deal with the more traditional environmental factors is taken for granted, even though such factors are known to be significant.

Perhaps the key to this list is the scarcity of remote, suitable land. This may seem paradoxical, given the extent of the country. This is by no means a new constraint in the more highly developed states. Surprisingly, however, it was identified as a significant constraint in such states as Louisiana, where it seems that there are still considerable amount of vacant land. National parks, national forests, Bureau of Land Management ownership, Indian Reservations and state lands, together with federal and state wild and scenic rivers and designated natural habitat areas, close off vast areas. In addition, increased settlement, travel and recreation in remote areas mean that "out of sight" is no longer "out of mind". A further concern is the sort of "invisible patchwork" that overlies much of the land. Encountering numerous agencies with varying regulations and somewhat haphazardly overlapping jurisdictions creates a significant challenge. Both of these constraints are likely to become more severe in the next decade.

For these reasons, transmission line planners are looking more closely at joint use of communication, highway and pipeline and existing transmission line corridors and at the need to consider traversing urban areas. While the need for more joint use increases the urgency of solving numerous electrical and electronic compatibility and safety problems, declining opportunities to avoid urban areas raises concerns that are more difficult to resolve.

Perhaps the most frequently mentioned constraint is not a constraint per se: the growing numbers of people do not want transmission lines or other energy or heavy industrial facilities close to them. This "not in my backyard" attitude, or NIMBY in the acronym coined by Florida Power and Light Company, is rarely if ever expressed openly. Instead, impacts on visual quality or property values may be given as the ostensible objections. This makes it difficult to anticipate and incorporate siting or routing factors systematically. More importantly, such factors tend to be relatively "soft", especially in urban or urbanizing areas, lacking objective standards of measurement.

It is important to remember, however, that the attention paid to other "soft" impacts over the past ten years, routing and mitigation techniques minimize rural visual impacts, for example, particularly in forested areas, have established relatively "hard" standards and methods of measurement and mitigation. A similar focus is required to establish hard, objective standards for locating facilities in urban areas, looking at the relative compatibility of specific facility types with various land uses and the mitigation of urban visual impacts. Attention is also needed to the difficulties of siting in sensitive areas, such as the desert southwest, where visibility is very high.

Regional Variations

The EPRI study also provides some insight into the way the state and local regulatory and attitudinal atmosphere in which energy companies operate varies regionally. At one end of the scale are older, highly developed areas where population density is high, suitable vacant sites and routes are limited, and concern about crowding and degrading open country and environmental quality are high.

Maryland exemplifies this end of the spectrum with accompanying regulatory processes that are both streamlined and rigorous. The Maryland energy facility siting process is the subject of another paper. This state has also achieved a high level of integration between the energy facility locators and local planning agencies. Local general plans are required to identify potential new transmission line corridors, protecting power companies' options and enhancing the potential for land use compatibility.

At the other end of the spectrum, are certain western states, such as Texas, Wyoming and Montana, with extensive sparsely populated areas, low overall population densities and low or largely indigenous growth rates. A generally laissez-faire approach has prevailed in these states and to a large extent still does. Wyoming, for example, has experienced the severe effects of unplanned energy project-related boom growth and has been the focus of studies of this particular syndrome. It is significant that power companies in Texas listed fewer constraints to transmission line routing than any others interviewed in the recent EPRI survey.

Somewhere between these extremes fall most of the sunbelt growth states where public consciousness and regulatory sophistication are high and increasing but have not reached the rigor of the east and west coasts. Like the Canadian west these states have experienced high rates of inmigration of well-educated people from more urbanized areas who have brought with them both increased environmental sensitivity and concern for pristine open spaces. Colorado exemplifies those states in this group where regulatory requirements are beginning to approach the sophistication of the more advanced states. Not all, however, have reached this point. Florida is something of a hybrid: preliminary scoping has recently been introduced at the state agency level; however, lack of comprehensive advance land use planning at the local level can result in developments unexpectedly obstructing apparently suitable routes.

These findings, while not comprehensive, suggest a simple model which can help in planning the appropriate type and level of public participation program and in anticipating the issues likely to be encountered in a project.

SUMMARY

In summary, it can be said that the state of the art of siting and routing has come far on the national level although many aspects of our knowledge and methods require improvement. While the process is not yet universally in use, the number of companies, agencies and states to which it is commonly accepted is increasing. It is difficult to assess the extent to which siting and routing decisions have been improved and speeded up as a result, at least on a percentage basis. The well-publicized problem projects are in most cases ones that were conceived well before the need for openness and comprehensive, systematic planning became accepted or are the result of ill-conceived project goals. However, increased communication among energy companies, researchers and planners and conferences such as the current one, is the best hope for continual improvement of the record.

SESSION I A - SITING

SITING A PETRO-CANADA HYDROCARBON FACILITY: THE RIM GAS PROJECT EXPERIENCE

DOUGLAS BRUCHET
GEOFFREY CHOW
ROBERT EVERITT

FORWARD

This paper was originally prepared in 1982 for the Symposium on the Environment held in Quito, Ecuador by the state owned oil company, ARPEL (Asistencia Reciproca Petrolera Estatal Latino Americana). It was written prior to the downturn in the petroleum industry, during a period of much industrial enthusiasm, when many mega projects were on the verge of becoming realities.

The siting concepts and decision processes are still relevant, applicable and defensible. The original paper has been updated for this conference "Facility Siting and Routing '84: Energy and Environment" (April, 1984). In addition to minor tense changes, a brief overview of two other siting projects and an update on the status of the siting of LNG projects on the west coast of British Columbia have been included.

Because the Rim Gas Project is currently "on hold" it is referred to in the present tense within the paper.

ABSTRACT

In 1980, Petro-Canada's Rim Gas Project undertook to select an optimal location on British Columbia's west coast for a gas liquefaction plant and supporting pipeline and marine terminal.

The $2.3 billion proposal to liquefy and ship natural gas to Japan was the first of its kind for B.C. Because of earlier proposals to ship Alaskan crude by tanker along the west coast of British Columbia to the United States, public interest in energy siting was heightened. A number of well-informed public interest groups in the province had already actively lobbied against oil transportation and oil ports siting. The concerns of government, the public, native groups and other organized offices and associations needed to be addressed in the very preliminary stages of the Rim Gas proposal. Consequently, the location and liquefaction terminal have become a focus of interest and concern, although government specifications for siting remain vague.

A multidisciplinary approach using a team of experts was taken, with significant input from expert local consultants, and federal and provincial officials. The siting methodology involved site identification, site screening and site comparison. An initial review of the west coast using existing literature, maps and aerial reconnaissance identified thirty-three potential sites. A further screening of these locations with respect to proximity of population reduced the number of sites to twelve. The third phase involved a rigorous comparison of the sites against: safety, environmental impact, socio-economic impact and project economics. This comparison entailed a

a definition of the issues and indicators, a description and evaluation of site impacts, and an overall analysis and comparison of candidate sites. The process was an iterative one, necessitating refinements and changes as new information became available. Indicators were converted to a scale of 0 to 100, indicating a progression from worst to best. An overall rating was determined by weighting, and totalling the category ratings into a single site score. Sensitivity analyses of the relative weights assigned to each of the major impact categories were conducted using fourteen different sets of weightings. The site selection study identified five good sites along the Kitimat Arm in Northern British Columbia, with Bish Cove and Gobeil Bay receiving the highest ratings. As a result of initiatives taken by the Kitamaat Band to have the Rim Gas Project use the Bish Cove site, Petro-Canada selected this site as the preferred location for the liquefaction and export terminal.

Although not devoid of the typical problems encountered in such an exercise, it is felt that this particular site selection methodology resulted in few major problems. Due to its simple design but rigorous application, the process is well suited to deal with changing priorities and events. The interdisciplinary approach to the site selection, both in terms of team composition and factors under study, resulted in a comprehensive and detailed holistic evaluation and defensible rationale for the ultimate selection of Bish Cove.

INTRODUCTION

> "We seem to be in infinite regress, leading sooner or later to a choice made by applying a process which cannot yet be specified to data which remain obscure."
>
> Geoffrey Vickers

In the past decade proponents of industrial projects, particularly energy-related ones, have become more accountable for their actions and decisions to government regulatory agencies and parties potentially affected by such projects. A history of environmental and social conflict that has resulted in costly project cancellations and delays has been associated with many new energy projects in Canada and elsewhere. Environmental management and planning has become, out of necessity, an integral part of new energy project development. The approach taken by Petro-Canada has been to give environmental and social concerns high priority and early consideration and to work towards solutions through innovative management techniques. To this end, Petro-Canada has placed a great deal of emphasis in determining optimum locations for its many operational activities.

The purpose of this paper is to review the general concepts associated with the site selection process and to describe a siting method that was used for a project of which Petro-Canada is the project manager: the RIM GAS Project.

The general theme of this paper attempts to demonstrate that, by undertaking an interdisciplinary, comprehensive site selection during the conceptual stages of energy project development, effective environmental decision making can become integrated into project design and development, thus mitigating potential negative impacts and enhancing opportunities.

SITING PROBLEMS

Because of the complexity of the technical and political issues involved in siting, there is no effective policy for selecting sites (Kenney, 1980), although the British Columbia Energy Project Review Process (1982) makes a beginning in this regard. Past experience has shown that the major question has been "whether" to site the facility as distinguished from "where" to site the facility (Linnerooth, 1980). The decision of whether to site a facility is often a highly political question of regional or national, and in some cases, global importance; the question of where to site the facility is of regional and local political importance. The decision to proceed with the project is the responsibility of the regulatory agencies; whereas the location of the facility is dependent on the environmental, social, economic, and safety concerns in the immediate area of the site and along any needed transportation routes to the site.

Site Selection as a Decision Problem

The distinction between the question of whether to site a facility versus the question of where to site a facility is extremely important. Ideally, the decision to site a facility would be made before the selection of a site begins. This is almost never the case, and for good reason. The process of selection serves to focus local attention on the siting problem. Information on the consequences of building the facility and on public attitudes toward the facility is often unavailable until proposals are on the table. Frequently there are competing proposals for the construction of a facility and it is impossible to evaluate the merits of each until the specifics of choosing a site are examined. While, in theory, the decision to site a facility should come first, in practice, the process of deciding where to site the facility is usually the important determinant in deciding whether or not to site the facility. This presents some challenging problems for the proponents, the regulators, and the public. The decision of where to site a facility involves a choice between alternative sites. In most siting cases, there are five major concerns: the environment, project economics, socio-economics, health and safety, and public attitudes. In deciding between alternatives, each of these general concerns must be considered.

In making siting decisions, it is necessary to make trade-offs among these general concerns associated with the project. Making the trade-offs clearly is a difficult task. Equally difficult, is defining a set of indicators to measure the impact of the project on each of the general concerns. The choice of the appropriate indicators is not a wholly objective pursuit and depends critically on the project under consideration and the people involved. Indicators need to be developed systematically by disciplinary experts in each of the areas of general concern.

The careful definition of indicators and scales to measure the impacts provides a yardstick to compare alternative sites. To make a meaningful comparison between sites it is necessary to weight each of the indicators in terms of its relative importance. To do this, a subjective assessment of values must be made. This implies the existence of a decision-maker or a decision-making body. The question of whose values to use in making the site selection is a difficult political question. Often in site selection studies, the weights assigned to the indicators reflect the values of the proponent tempered by a concern to act in the public interest.

When viewed as a decision problem, site selection is the choice between alternative sites on the basis of a comparison of indicators. The indicators are weighted to reflect the values and objectives of the decision maker. This simple view of site selection is complicated by the numerous possible sites that must be considered and the multiple objectives and values that are represented by the various interest groups in society. In addition, there are many intangibles (aesthetics, fear, etc.) that are difficult to measure.

While many of these complications can be dealt with, the difficulties caused by uncertainty about impact cannot. Keeney (1980) lists the major reasons for the existence and persistence of uncertainties as these: little or no data can be gathered for some events; some data are very expensive or time consuming to obtain; natural phenomena such as earthquakes and drought affect impacts; people move, affecting future impacts; priorities are not static and, hence, perceived impacts change over time; and it is impossible to forecast the future completely. The existence and persistence of uncertainty must be explicitly acknowledged in site selection.

The complexity of the siting problem, both in terms of the factors that must be considered and the number of people involved, make it imperative that a systematic approach to gathering, analyzing, and evaluating information be used. Explicit analysis facilitates logical accounting of what is relevant and provides a framework for integrating the information of numerous disciplinary experts into the overall siting problem. Because of the necessity to document the siting decision for some regulatory agencies, systematic analysis is important to provide a consistent rationale for the decision. It provides documentation of what information was collected, how it was used and how the preferred site was selected.

While formal analysis of the siting problem provides documentation of the siting decision, the process of conducting the analysis can provide much more. Through their participation in the analysis, the public and the regulatory bodies can be educated about the project, its management, and its possible consequences. Because the process provides the opportunity to look at all aspects of siting, it helps the proponent, the regulators, and the public reassign priorities as the analysis evolves. This is particularly important to identify more specific criteria and allow for more detailed impact assessments that may be required for the chosen site.

Siting of Large Energy Facilities: Applications

The siting problem is not new; many studies have been conducted, and many facilities constructed. Previous experience in analyzing the siting problem falls into two classes: site selection studies designed to choose between sites, and risk analysis designed to determine the risk associated with a given site.

A site selection study for the Atlantic Coast LNG receiving terminal for Petro-Canada's Arctic Pilot Project (Whitman, Benn & Associates, circa 1980) adopted a comprehensive approach and defined 78 site evaluation factors. An ad hoc scheme assigned a value and weighting to each of the factors to develop a quantitative score for each of the sites. In the site selection study for the Arctic Pilot Project's LNG terminal and regasification facilities on the St. Lawrence River (André Marsan & Associés Inc., 1979), a comprehensive list of site factors was developed and a ranking by series method was used to evaluate sites.

A comparative environmental risk analysis (Fisheries and Environment Canada, 1978) of Pacific coast oil ports developed four indices: navigational risk, biological resource, economic resource, and social resource. These indices were used to determine the ranking of 27 port/route alternatives in terms of environmental impact and environmental risk. A ranking by series scheme was used, and the navigation risk index was designed to consider the relative probability of an oil spill for the various port/route options.

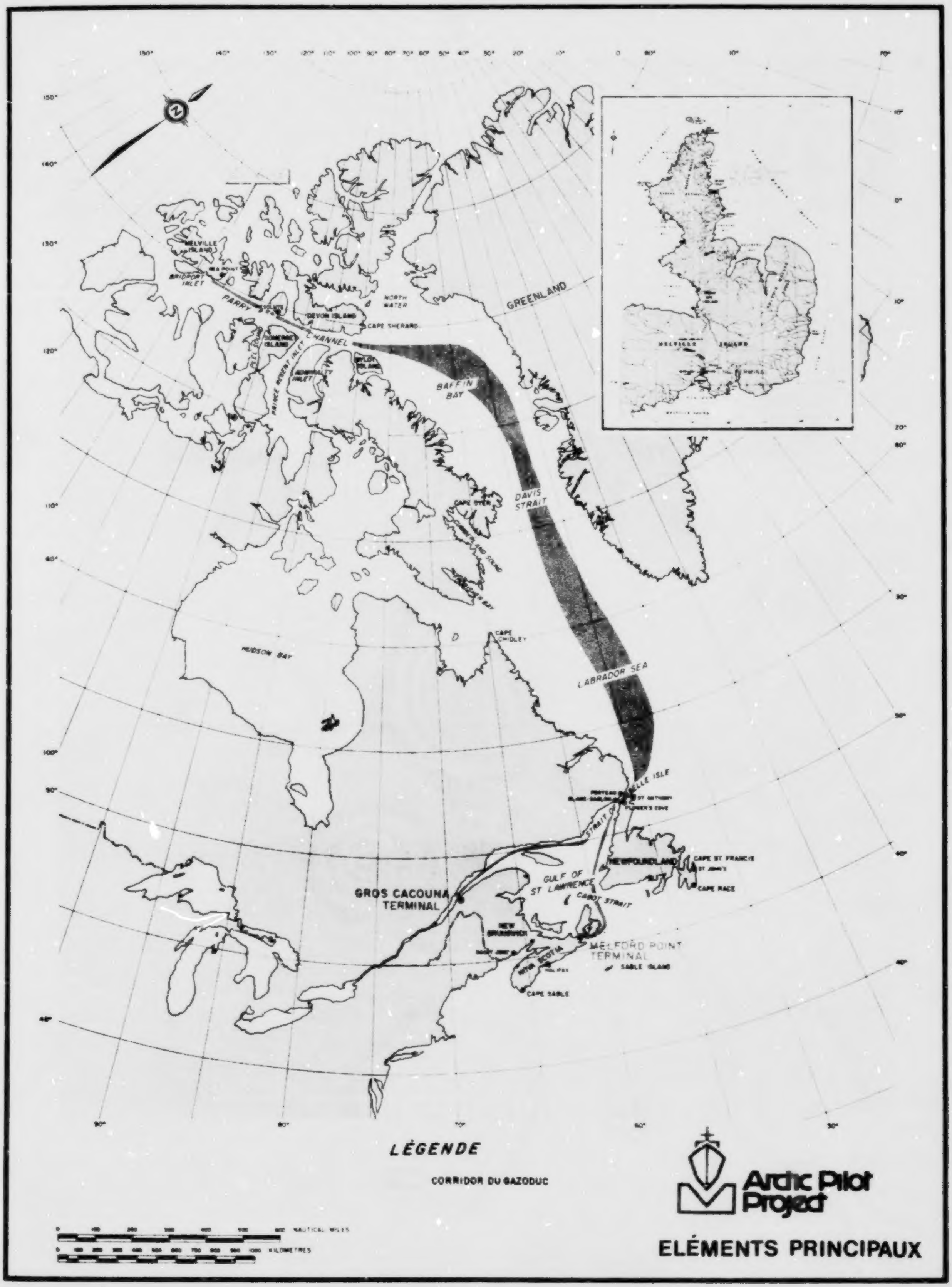
In developing a process for siting hydrocarbon facilities on the Canadian Arctic Coast, Rogers, Golden & Halpern (1982) reviewed a number of site selection methodologies based on U.S. experience and site selection studies in Canada. From that, they suggest a detailed five step process, focusing on environmental criteria. The first four steps are concerned with identifying and screening sites. The fifth step - selecting the preferred site - involves the ranking or rating of the alternate sites. They do not offer a rigorous method of ascertaining preferences and trade-offs but rather, the choice is left to the analyst.

Dome Petroleum's siting document (Tera Consultants, 1981) for their Western LNG Project in northern British Columbia, discusses their site selection process. Initial studies identified a number of potential sites that were then evaluated against environmental and socio-economic determinants. Sites were eliminated based firstly on risk, secondly on engineering feasibility and finally on an arbitrary score limit. An impact matrix was then used to generate scores on the remaining sites. No weighting of the determinants was made and consequently there is nothing to distinguish social impacts from terrestrial or aquatic. As a final step, the scores of the determinants were totalled, and the remaining sites were ranked numerically.

Gulf Canada Resources undertook a site selection study to determine an optimum location for a marine support base on the Beaufort Sea coast (Gulf Canada Resources, 1982). Their documented decision analysis process separates selection criteria into two types, definitive criteria and relative criteria. Eight definitive criteria assisted in the identification of sites which were technically and economically feasible and ten relative criteria were applied to evaluate the differences between the sites, resulting in the selection of Stokes Point as the preferred site. In November, 1982 Gulf's application to the Department of Indian and Northern Affairs to develop Stokes Point was rejected.

All of these siting applications have applied, to some extent, a decision analysis approach to evaluating sites. A more rigorous application of this approach is outlined in Keeney's (1980) description of an evaluation of proposed pumped storage sites in the American Southwest and in the selection of nuclear power plant sites in the Pacific Northwest (Keeney and Nair, 1977). In these applications, emphasis is placed on assessing preferences and trade-offs between a set of carefully defined indicators. Careful attention was given to value assignments for the indicators and to making explicit the uncertainty and risk associated with the siting problem.

Most of the foregoing applications have concentrated on comparing sites and selecting the preferred site. In some siting problems, this is sufficient, while in others, it is not. In many siting problems a dominant concern is public safety; this is particularly true of nuclear sites and liquid natural gas (LNG) facilities. Because of the potential hazard associated with these facilities, rigorous risk assessments are often made to assess the likelihood and potential consequences of an accident. These analyses are usually performed after a single site has been selected or after the choice has been narrowed to two or three competing sites.


MELVILLE ISLAND
BRIDPORT INLET
PARRY
CHANNEL
DEVON ISLAND
NORTH WATER
CAPE SHERARD
SOMERSET ISLAND
PRINCE REGENT INLET
ADMIRALTY INLET
BYLOT ISLAND
GREENLAND
BAFFIN BAY
DAVIS STRAIT
CAPE DYER
CAPE CHIDLEY
HUDSON BAY
LABRADOR SEA
STRAIT OF BELLE ISLE
ST ANTHONY
FLOWER'S COVE
NEWFOUNDLAND
CAPE ST FRANCIS
ST JOHN'S
CAPE RACE
GULF OF ST LAWRENCE
CABOT STRAIT
GROS CACOUNA TERMINAL
NEW BRUNSWICK
NOVA SCOTIA
MELFORD POINT TERMINAL
SABLE ISLAND
CAPE SABLE
MELVILLE
ISLAND
LÉGENDE
CORRIDOR DU GAZODUC
NAUTICAL MILES
KILOMETRES
Arctic Pilot Project

ELÉMENTS PRINCIPAUX

The Institute for Applied Systems Analysis (IASA) has been studying the role of risk analysis in the decision-making process surrounding the siting of LNG facilities (Kunreuther et al, 1982). Examination of four in-depth case histories in four different countries revealed very different biases in the approach to risk analysis for siting. In general, these analyses attempt to quantify risk by constructing accident scenarios. A typical scenario begins with an LNG accident which causes a fire or a spill. If a spill occurs, the dynamics and size of the vapour cloud are modelled. Assumptions are made about the likelihood of ignition of the cloud and fatalities from an ignited vapor cloud are estimated. Four measures often used to quantify associated risk are as follows: expected number of annual fatalities, risk to an individual, risk to an individual in a given group, and the probability that the number of fatalities is greater than a specific level.

The attempt to develop a meaningful quantification of risk is motivated by a desire to provide input into the decision regarding acceptability of the risk associated with a given site. The development of acceptable risk criteria is extremely difficult because of the number of uncertainties associated with particular sites. While there are a number of models for quantifying the risk from LNG facilities, the question of whether a site is acceptable will always depend on more than the analysis. Because no site is completely safe, there will always be a constituency of people who believe the risk is unacceptable.

The considerable effort and analysis that have gone into siting have generated a number of approaches to the problem. The remainder of this paper is devoted to a description and discussion of an approach to siting an LNG facility which, from an environmental management perspective, positively affected the design and development of the facility.

RIM GAS PROJECT

Project Description

The RIM GAS Project is a $2.3 billion proposal to liquefy natural gas at facilities on the west coast of Canada (figure 1) and transport the liquefied natural gas (LNG) by ship to Japan.

The major components of the project are: a gas pipeline, a liquefaction plant and export terminal, and three LNG carriers.

The impacts of the project, both positive and negative will, in large part be dependent on the location of the liquefaction terminal. For this reason Petro-Canada, as the project operator, initiated a site selection study in 1980 to determine the optimum location for the terminal.

Overview of Northern British Columbia Environment

British Columbia lies within the belt of westerly winds which contains an almost continuous sequence of extra-tropic cyclones or lows. These cyclones are usually in a mature stage upon reaching the British Columbia coast, bringing large amounts of precipitation and frequent gales, resulting in an almost consistently cloudy and wet climate throughout the year.

The rugged northern British Columbia coastline is the product of glacial scouring, volcanic activity, and the uplifting of the land due to the recession of the seas. The Coastal Mountain Range is the dominant topographical feature along the coast. The deep fjords that frequently occur are remnants of glacial activity.

The wet temperate climate has led to the establishment of thick fir forests. The vegetation cover is described as temperate marine rain forest, growing on poorly developed soils. Terrestrial wildlife is generally limited by high precipitation along the coast, and heavy snowfall further inland. Agriculture is limited by poor soils. The major industries are mining, logging and commercial fishing.

The rugged rocky coastline provides habitat sheltered from the ocean and has thus led to the development of a rich marine fauna. Whales and porpoises use the oceanic and inshore waters. Other sea mammals, such as seals, otters and sea lions frequent rugged outer coasts for most activities and protected inshore waters for feeding and rearing of their young. Several species of commercial fish, such as herring and salmon, frequent the inshore waters of the northern coast. All five species of Pacific salmon make use of freshwater systems for spawning. The warm inshore waters, active currents, and freshwater inputs make this section of the coast biologically productive at all trophic levels. North coast fishing activities account for about 43% of the total coastal salmon catch, and approximately 54% of the non-salmonid catch.

Waterfowl use the north coast for many stages of their life cycles. Large flocks of sea birds, geese and shorebirds feed and overwinter in the inshore areas. Bald eagles are also common in the area. The coniferous forests provide habitat for many species of birds, particularly passerines, crows and ravens.

The vast wilderness areas are important for ungulates, especially blacktail deer and moose, as well as mountain goats. Black bear and grizzly bear are common big game animals.

Regulatory Requirements

In the early stages of project development, a comprehensive review of the regulatory requirements that the RIM GAS Project would have to address was undertaken. In Canada both federal and provincial review processes apply. The two federal agencies that have responsibility for reviewing the RIM GAS Project are the National Energy Board (NEB) and the TERMPOL Committee, an inter-departmental body coordinated by the Ministry of Transport to review marine-related hydrocarbon projects. At the provincial level, the British Columbia Utilities Commission (BCUC) is responsible for energy project regulation. These three agencies require, in some form or another, public interest-related documentation. This documentation has been submitted in the past to these agencies in the form of environmental impact statements (EIS).

The NEB has no formal requirement for site selection documentation although it requires environmental information on alternates and reasons for selecting proposed pipeline routes. The TERMPOL Committee does not require formal site selection documentation. The Guide to the Energy Project Review Process prepared to assist energy project applicants in British Columbia indicates a requirement for siting information. The procedures to be used by applicants in site selection are general and allow considerable flexibility in choosing a siting method.

Site Selection Process

The RIM GAS Project, at a very early stage, initiated activities which would facilitate public review of the project as well as assist project management in its decision making.

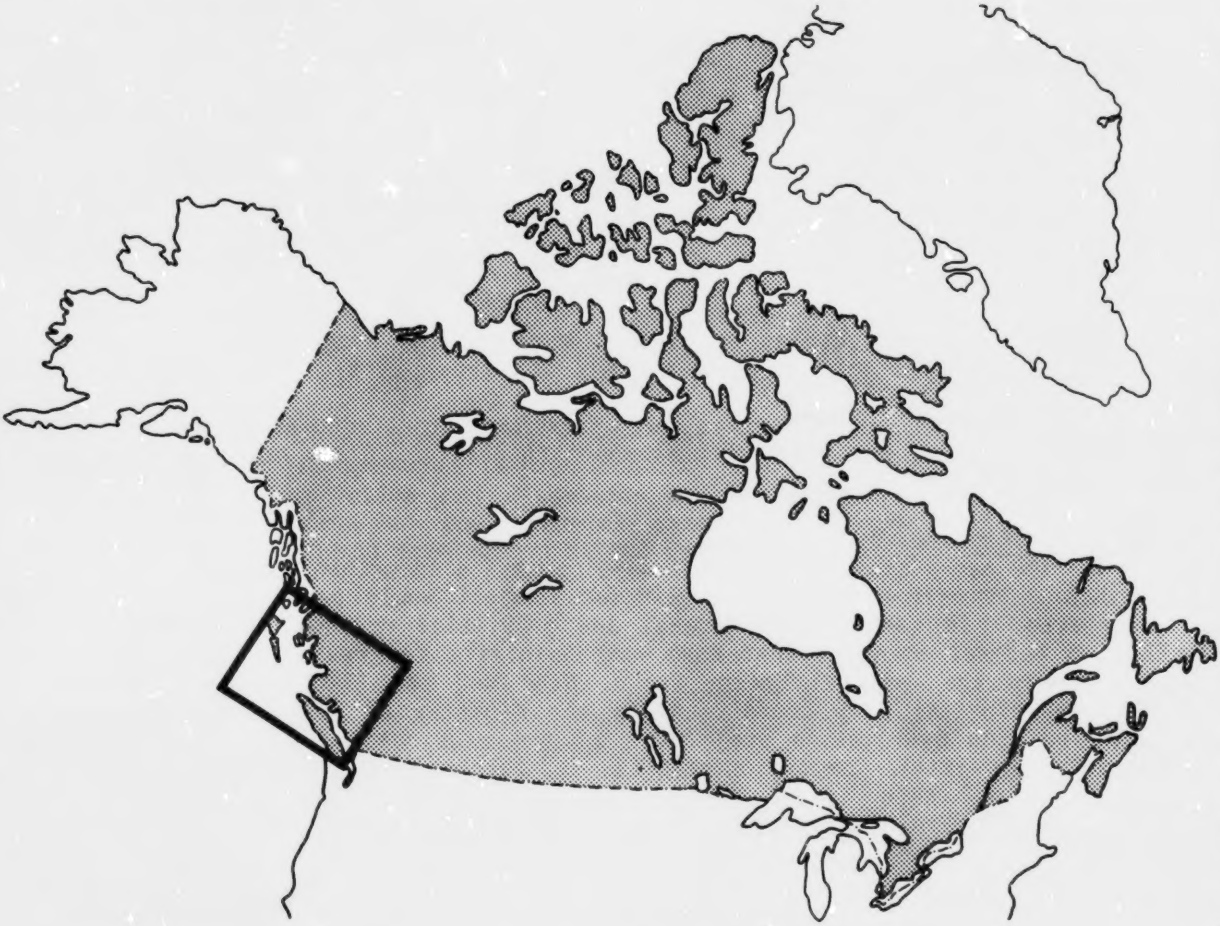

100 0 100 200 300 400 Miles
200 0 200 400 600 Kilometres

FIGURE 1

CANADA SHOWING RIM GAS
STUDY AREA

The main objective of the site selection for the RIM GAS Project was the selection of a site which would have the fewest potential impact problems. There are few environmental concerns associated with liquefied natural gas (LNG) projects, as natural gas in liquid or vapour form is relatively non-polluting. The main public interest issue associated with LNG projects is public safety with respect to the possibility of an accidental spill from a ship or at a terminal. Environmental, socio-economic and economic factors also influence the direction of the decision-making process.

The RIM GAS site selection study was carried out by a multidisciplinary team of Petro-Canada and west coast staff, and several consultants. The consultants were, for the most part, based on the west coast and had extensive experience with conditions there. Study elements relating specifically to LNG were handled by leading consultants in this highly specialized field. Provincial and federal officials provided a large amount of important data for the study and participated at the earliest stage in field visits and discussion sessions.

The methodology used for site selection involved three major steps: site identification, site screening, and site comparison. The entire process (figure 2), documented in the site selection study (RIM GAS Project, 1982) is briefly described below.

Thirty-three potential sites in twelve areas (figure 3) were initially identified through a review of past port development proposals, examination of maps and charts and aerial field reconnaissance. These sites were then screened according to the board criteria listed below:

(1) Total population occurring within 1 km of the entire length of the shipping route in British Columbia does not exceed 1000.
(2) Total population occurring within 10 km of the entire length of the shipping route in British Columbia does not exceed 100,000.
(3) The area within 1 km of the proposed terminal site is unpopulated.
(4) The population between 1 km and 2.5 km of the proposed terminal site does not exceed 1000.
(5) There are no navigational hazards that would present an unacceptable risk to the LNG carriers and their crews along any part of the shipping route.
(6) There are no major concerns within any two of the following three areas: environmental impact, socio-economic impact and project economics.

Any site for which one or more of the above criteria could not be met was eliminated from further consideration. This process resulted in the elimination of 21 of 33 potential sites. The remaining 12 sites (figure 4) were subjected to a rigorous comparative evaluation of their safety, environmental impact, socio-economic impact and project economics, based on techniques described in Keeney and Raiffa (1976) and Keeney (1980). The methodology (outlined in figure 5) involved four basic steps: definition of issues and indicators, description of site impacts in terms of indicators, evaluation of site impacts, and analysis and comparison of candidate sites.

The definition of indicators was accomplished by using the consensus of disciplinary experts. The method used (outlined in figure 6) began with a broad discussion of issues for each of the major concerns: safety, environment, socio-economic, and project economics. From these key issues, sets of indicators were developed to measure each issue. For example, the environmental issue represented by the impact of the facility of salmon escapement was measured by the assessment of the number of salmon potentially affected (figure 6).

The definition of the indicators was a major task requiring the disciplinary experts to concentrate on the most important potential impacts. This made explicit the information needed from the supporting studies conducted to describe the site impacts. The disciplinary experts were required to quantify impacts in terms of the indicators defined, thereby ensuring the relevance of information to the site selection process. Through a process of data collection and compilation of information, estimates for each of the indicators for each of the sites were obtained. At times throughout the process of describing site impacts, the indicators had to be refined to incorporate new information and understanding.

All indicator values were subsequently converted to a scale of 0 (worst) to 100 (best) in order to standardize the data for comparison purposes. When more than one indicator was required to describe a category of concerns (i.e., environmental and socio-economic impacts), the values of the indicators were weighted and combined to produce an overall rating for each category. The assessment of the relative importance of each of the impact categories was based on the RIM GAS Project management preferences tempered by a concern to act in the public interest. An overall rating was determined by weighting and combining the individual category ratings into a single site score (figure 5).

The final analysis and comparison of the sites involved two parts: calculating the overall site rating and making a sensitivity analysis of the relative weights assigned to each of the major impact categories. Calculation of the overall site ratings was relatively straightforward. Sensitivity analyses were conducted with varying degrees of bias towards each of the environmental, socio-economic, project economics, and safety concerns. In all, fourteen different sets of weightings were used to test the sensitivity of the site ratings to changes in preferences.

Results

The results of the site selection study are summarized in table 1. The Kitimat Arm area was determined to be the best location for the proposed LNG terminal. Five sites along the arm appeared to be relatively equal in suitability. These sites were at Gobeil Bay, Clio Bay, Bish Cove, Emsley Cove and Markland Point.

These five Kitimat Arm sites have excellent ratings for eight of ten indicators used for comparative site evaluation. Their only shortcomings are a relatively low potential for local employment and water use conflicts. Their positive attributes (high public safety ratings, absence of significant environmental impact, and attractive project economics) far outweigh the negatives.

Further analysis was performed to determine the sensitivity of the results to changes in the weighting assumptions. These analyses revealed that the five best Kitimat Arm sites retained their high overall scores with any weighting scheme that gives some emphasis to all four impact categories.

Depending on the weighting scheme adopted, either Gobeil Bay or Bish Cove received the highest overall rating. The scores of the other three sites were only marginally lower. It was concluded that no meaningful distinctions could be made among the five best sites on Kitimat Arm.

Of the other sites considered in the study, the two remaining Kitimat Arm sites ranked next to the five best Kitimat sites. However, it is difficult to envision why either of these sites would be chosen when better sites are available in the area. Of the five sites outside the Kitimat area, three - Smith Island, Kitson Island and Grassy Point - appear to be feasible but not optimal. Two sites, Ridley Island and Dawkins Point, are clearly inferior to all of the other sites.

While the site selection study was underway, the Kitamaat Indian Band approached the RIM GAS Project regarding the possibility of establishing a long-term agreement for a terminal on Band property at Bish Cove. Negotiations between the Kitamaat Indian Band and the RIM GAS Project subsequently ensued, indicating a strong local preference for the Bish Cove site. The RIM GAS Project, after considering this situation in conjunction with the results of the site selection study, selected Bish Cove as its preferred site.

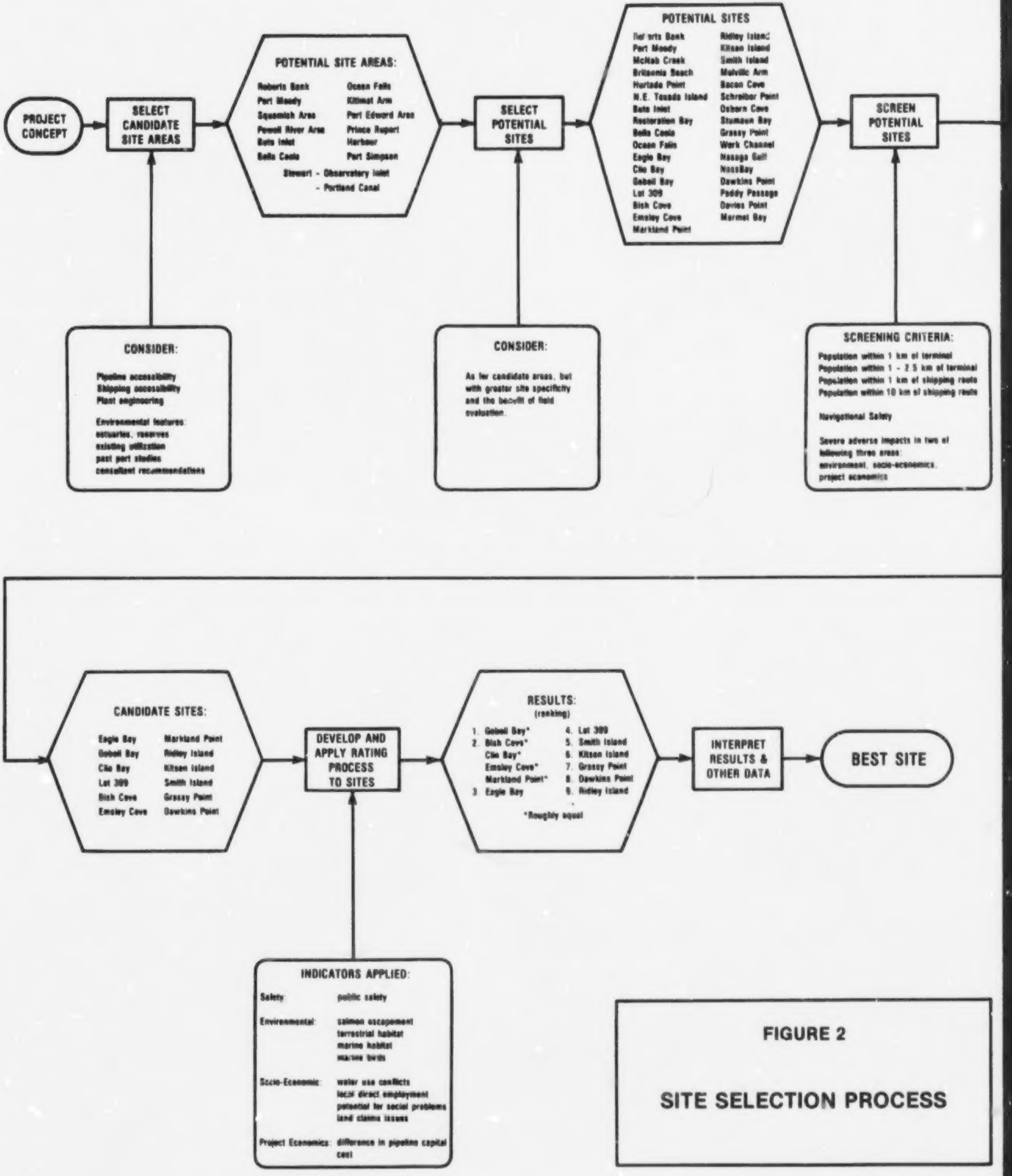

PROJECT CONCEPT
SELECT CANDIDATE SITE AREAS
POTENTIAL SITE AREAS:
Roberts Bank
Port Moody
Squamish Area
Powell River Area
Bute Inlet
Bella Coola
Ocean Falls
Kitimat Arm
Port Edward Area
Prince Rupert Harbour
Port Simpson
Stewart - Observatory Inlet
- Portland Canal
SELECT POTENTIAL SITES
POTENTIAL SITES
Roberts Bank
Port Moody
McNab Creek
Britannia Beach
Hurtado Point
N.E. Texada Island
Bute Inlet
Restoration Bay
Bella Coola
Ocean Falls
Eagle Bay
Clio Bay
Gobeil Bay
Lot 309
Bish Cove
Emsley Cove
Markland Point
Ridley Island
Kitson Island
Smith Island
Melville Arm
Bacon Cove
Schreiber Point
Osborn Cove
Stumaun Bay
Grassy Point
Work Channel
Nasoga Gulf
NassBay
Dawkins Point
Paddy Passage
Davies Point
Marmot Bay
SCREEN POTENTIAL SITES
CONSIDER:
Pipeline accessibility
Shipping accessibility
Plant engineering
Environmental features:
estuaries, reserves
existing utilization
past port studies
consultant recommendations
CONSIDER:
As for candidate areas, but with greater site specificity and the benefit of field evaluation.
SCREENING CRITERIA:
Population within 1 km of terminal
Population within 1 - 2.5 km of terminal
Population within 1 km of shipping route
Population within 10 km of shipping route
Navigational Safety
Severe adverse impacts in two of following three areas:
environment, socio-economics, project economics
CANDIDATE SITES:
Eagle Bay
Gobeil Bay
Clio Bay
Lot 309
Bish Cove
Emsley Cove
Markland Point
Ridley Island
Kitson Island
Smith Island
Grassy Point
Dawkins Point
DEVELOP AND APPLY RATING PROCESS TO SITES
RESULTS:
(ranking)
1. Gobeil Bay*
2. Bish Cove*
Clio Bay*
Emsley Cove*
Markland Point*
3. Eagle Bay
4. Lot 309
5. Smith Island
6. Kitson Island
7. Grassy Point
8. Dawkins Point
9. Ridley Island
*Roughly equal
INTERPRET RESULTS & OTHER DATA
BEST SITE
INDICATORS APPLIED:
Safety: public safety
Environmental: salmon escapement
terrestrial habitat
marine habitat
marine birds
Socio-Economic: water use conflicts
local direct employment
potential for social problems
land claims issues
Project Economics: difference in pipeline capital cost

FIGURE 2

SITE SELECTION PROCESS

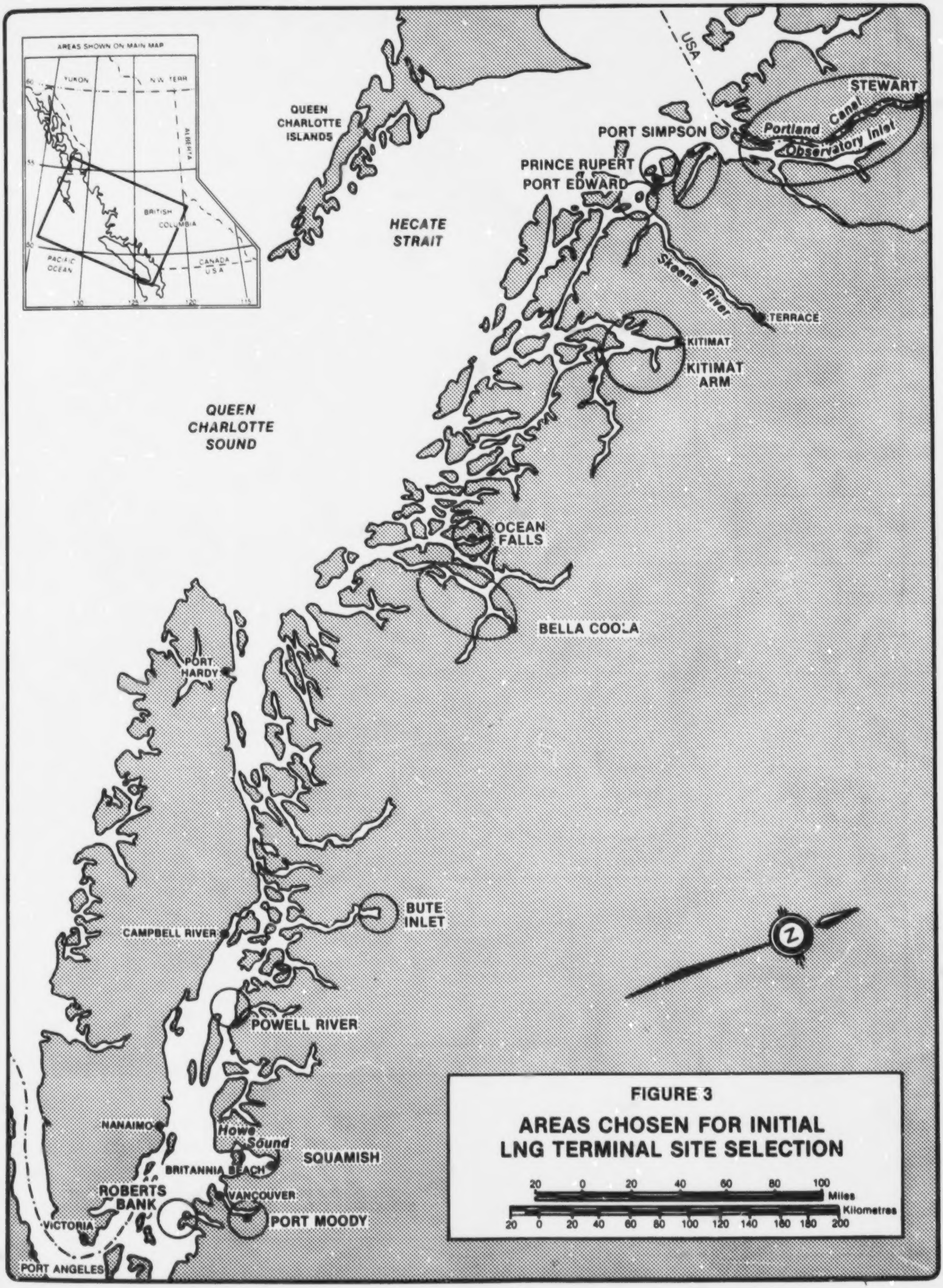


FIGURE 3

AREAS CHOSEN FOR INITIAL LNG TERMINAL SITE SELECTION

AREAS SHOWN ON MAIN MAP
YUKON
N.W. TERR
ALBERTA
BRITISH COLUMBIA
PACIFIC OCEAN
CANADA
USA
QUEEN CHARLOTTE ISLANDS
HECATE STRAIT
QUEEN CHARLOTTE SOUND
USA
STEWART
Portland Canal
Observatory Inlet
PORT SIMPSON
PRINCE RUPERT
PORT EDWARD
Skeena River
TERRACE
KITIMAT
KITIMAT ARM
OCEAN FALLS
BELLA COOLA
PORT HARDY
BUTE INLET
CAMPBELL RIVER
POWELL RIVER
NANAIMO
Howe Sound
SQUAMISH
BRITANNIA BEACH
VANCOUVER
ROBERTS BANK
PORT MOODY
VICTORIA
PORT ANGELES
N
20 0 20 40 60 80 100 Miles
20 0 20 40 60 80 100 120 140 160 180 200 Kilometres

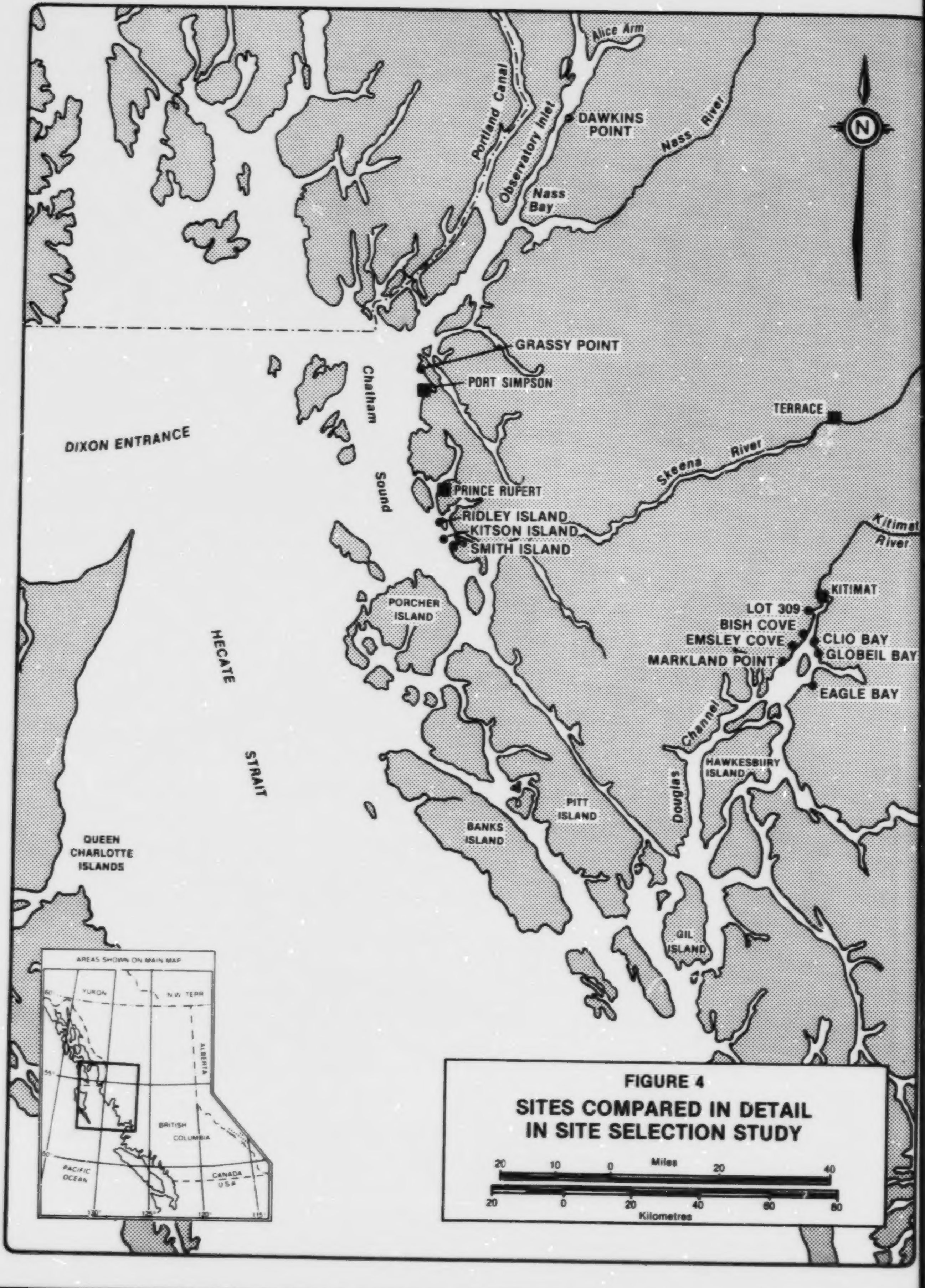

Alice Arm
Portland Canal
Observatory Inlet
DAWKINS POINT
Nass River
Nass Bay
GRASSY POINT
PORT SIMPSON
Chatham Sound
DIXON ENTRANCE
TERRACE
Skeena River
PRINCE RUPERT
RIDLEY ISLAND
KITSON ISLAND
SMITH ISLAND
Kitimat River
KITIMAT
LOT 309
BISH COVE
EMSLEY COVE
CLIO BAY
GLOBEIL BAY
MARKLAND POINT
EAGLE BAY
PORCHER ISLAND
HECATE STRAIT
Douglas Channel
HAWKESBURY ISLAND
PITT ISLAND
BANKS ISLAND
QUEEN CHARLOTTE ISLANDS
GIL ISLAND
N
AREAS SHOWN ON MAIN MAP
YUKON
N.W. TERR.
ALBERTA
BRITISH COLUMBIA
PACIFIC OCEAN
CANADA
U.S.A.
60
55
130
125
120
115
Miles
20
10
0
20
40
Kilometres
20
0
20
40
60
80

FIGURE 4

SITES COMPARED IN DETAIL IN SITE SELECTION STUDY

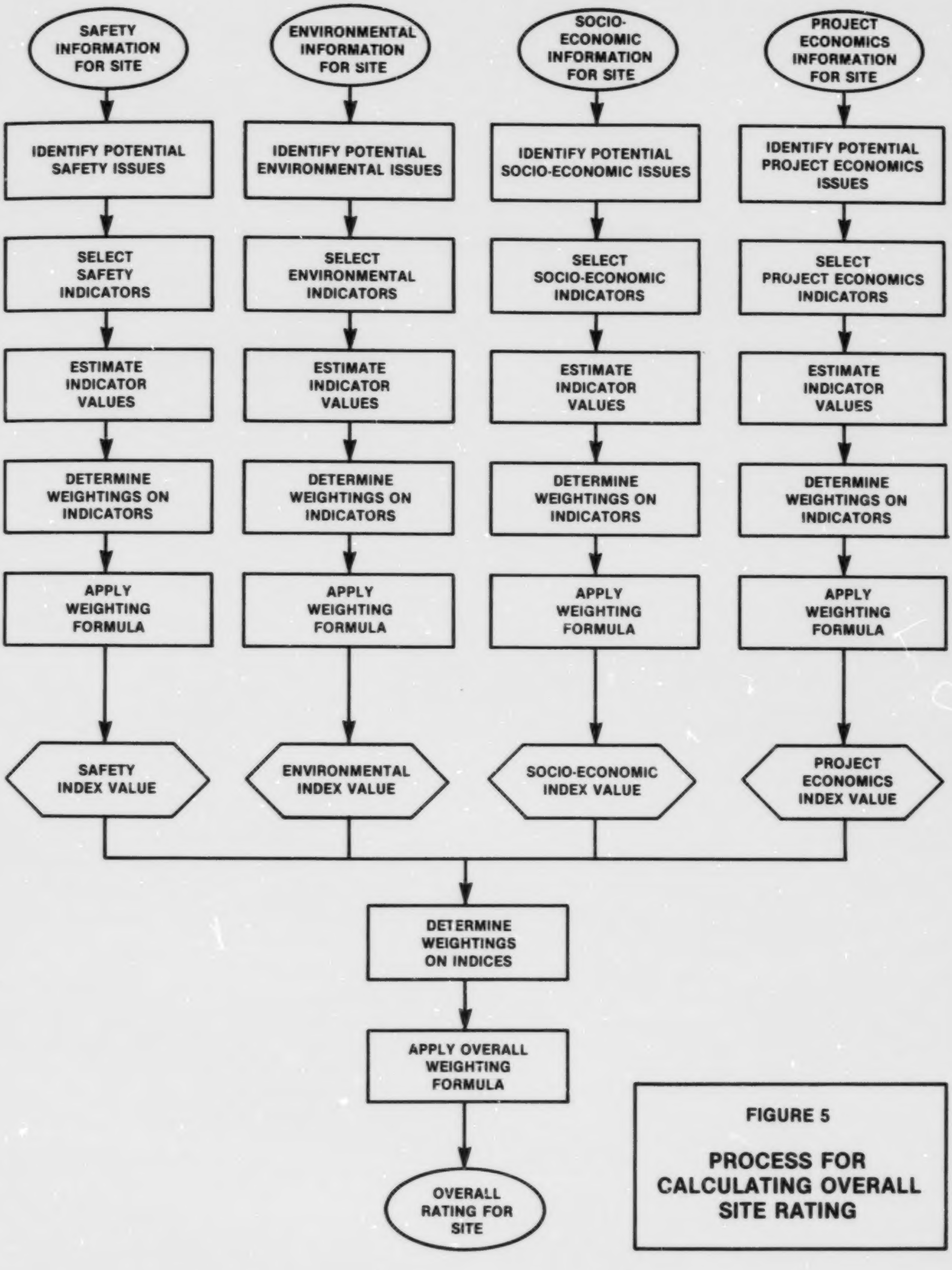

SAFETY INFORMATION FOR SITE
ENVIRONMENTAL INFORMATION FOR SITE
SOCIO-ECONOMIC INFORMATION FOR SITE
PROJECT ECONOMICS INFORMATION FOR SITE
IDENTIFY POTENTIAL SAFETY ISSUES
IDENTIFY POTENTIAL ENVIRONMENTAL ISSUES
IDENTIFY POTENTIAL SOCIO-ECONOMIC ISSUES
IDENTIFY POTENTIAL PROJECT ECONOMICS ISSUES
SELECT SAFETY INDICATORS
SELECT ENVIRONMENTAL INDICATORS
SELECT SOCIO-ECONOMIC INDICATORS
SELECT PROJECT ECONOMICS INDICATORS
ESTIMATE INDICATOR VALUES
ESTIMATE INDICATOR VALUES
ESTIMATE INDICATOR VALUES
ESTIMATE INDICATOR VALUES
DETERMINE WEIGHTINGS ON INDICATORS
DETERMINE WEIGHTINGS ON INDICATORS
DETERMINE WEIGHTINGS ON INDICATORS
DETERMINE WEIGHTINGS ON INDICATORS
APPLY WEIGHTING FORMULA
APPLY WEIGHTING FORMULA
APPLY WEIGHTING FORMULA
APPLY WEIGHTING FORMULA
SAFETY INDEX VALUE
ENVIRONMENTAL INDEX VALUE
SOCIO-ECONOMIC INDEX VALUE
PROJECT ECONOMICS INDEX VALUE
DETERMINE WEIGHTINGS ON INDICES
APPLY OVERALL WEIGHTING FORMULA
OVERALL RATING FOR SITE

FIGURE 5

PROCESS FOR CALCULATING OVERALL SITE RATING

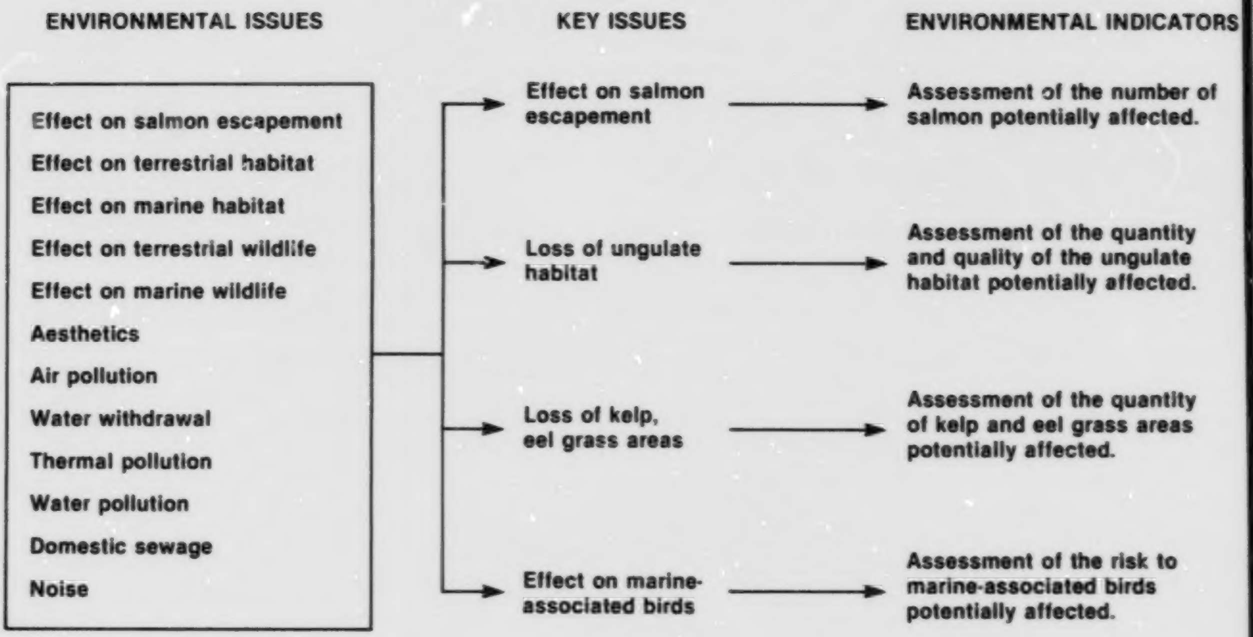

ENVIRONMENTAL ISSUES
KEY ISSUES
ENVIRONMENTAL INDICATORS
Effect on salmon escapement
Effect on terrestrial habitat
Effect on marine habitat
Effect on terrestrial wildlife
Effect on marine wildlife
Aesthetics
Air pollution
Water withdrawal
Thermal pollution
Water pollution
Domestic sewage
Noise
Effect on salmon escapement
Loss of ungulate habitat
Loss of kelp, eel grass areas
Effect on marine-associated birds
Assessment of the number of salmon potentially affected.
Assessment of the quantity and quality of the ungulate habitat potentially affected.
Assessment of the quantity of kelp and eel grass areas potentially affected.
Assessment of the risk to marine-associated birds potentially affected.

FIGURE 6

SELECTION
OF ENVIRONMENTAL INDICATORS

TABLE 1 OVERALL SITE RATINGS

Terminal Alternative	Rating By Category				Overall Rating
	Safety (w = .35)	Environmental (w = .15)	Socio-Economic (w = .20)	Project Economics (w = .30)	
Eagle Bay	100	91	62	60	79 (3)**
Gobeil Bay	100	91	62	96	90 (1)
Clio Bay	96	90	62	97	89 (2)
Lot 39	55	91	62	100	75 (4)
Bish Cove	96	91	62	98	89 (2)
Emsley Cove	100	87	62	96	89 (2)
Markland Point	100	91	62	92	89 (2)
Smith Island	90	78	69	52	73 (5)
Kitson Island	78	66	70	52	67 (6)
Ridley Island	13	78	70	55	47 (9)
Grassy Point	74	82	46	56	64 (7)
Dawkins Point	100	69	49	10	58 (8)

* Weight given to each category in calculating overall site ratings

** Overall rank of site

Constraints, Uncertainties, and Limitations of Analysis

The description of the site selection process reveals few of the frustrations and problems of employing a systematic methodology to site selection although many of the typical problems were present: lack of data for some indicators at some sites; problems or expense of obtaining missing data given the timing of the study; inability to predict future events, whether natural catastrophes, accidents, social changes or political decisions; and the effect on the perceived importance of impacts by changing priorities at any given time. The site selection process was well adapted to deal with the uncertainty of changing priorities throughout the study because of its simple, but nonetheless, rigorous design. Its flexibility in design will make it adaptable in the event of further changes in priorities and political decisions.

A major constraint placed on the study was the need to express the methodology in simple and comprehensible terms. This constraint should not be considered a limitation, for it is highly consistent with the role of the site selection study in the regulatory process and in RIM GAS Project development. By its very nature, site selection is an interdisciplinary problem. Ideas, opinions, and information from many experts must be integrated into a framework design for selecting a site. A simple but rigorous design goes far to ensure that all understand their roles, the information they must provide, and why it is required.

One of the main problems encountered in managing the site selection process was the difficulty experienced by some team members in interdisciplinary communication. This sometimes led to requests for more time and money to gather information. Other members had great difficulty focusing their concerns on a few key issues, and even greater difficulty developing quantitative measures for the indicators. After clearly defining the indicators, however, most were readily able to trade off between them.

Perhaps the most significant limitation of a formal analysis applied to siting problems is that the quantitative results, at best, reflect qualitative differences between sites. Small quantitative differences in ratings of sites are not sufficient to distinguish between sites because of the uncertainty involved. Because of this, what is omitted from the analysis is often the decisive factor.

Role of the Site Selection Study in Project Development

The site selection study was conducted by an interdisciplinary team with expertise in environmental matters, socio-economic concerns, economics, engineering, safety, and site selection methodology. RIM GAS Project management used the site selection study in a number of innovative ways to facilitate project development. The process of conducting the study made clear the importance project management placed on considering environmental, socio-economic, and safety aspects as of equal concern with engineering and economic aspects during project design. At times, it appeared that the primary driving force behind the project was to find a safe, environmentally acceptable site that would provide substantial social and economic benefit.

RIM GAS Project management used the site selection study to critically evaluate a number of alternative sites. The formal analysis that was conducted provides a defensible rationale for the selection of the preferred site that can be used as a justification to corporate management and to regulatory agencies. The analysis provides the RIM GAS Project management with a good understanding of the strengths and weaknesses of a number of sites. This is useful in a number of ways that relate to the regulatory process. First, project management has a preliminary assessment of the key issues relative to the preferred site. Second, in the case of competing projects at alternative sites, project management has a good knowledge of the strengths and weaknesses of the opponent's site. Finally, should political preference or society's values change, alternative sites can be used.

In general, by providing the ability to look at the project in total, the site selection process has allowed project management to assign priorities as the project evolves. It has focused issues and suggested criteria for more specific impact assessments required for the selected sites. By providing an integrative framework for assimilating and synthesizing the extensive information, the site selection study contributed much to the understanding that made this possible.

Current Project Status

From 1980 to mid 1982 there were several projects proposing to export British Columbia's natural gas, including Petro-Canada's RIM GAS Project and Dome's Western LNG Project. The site selection documentation presented by the RIM GAS Project to British Columbia received high praise in terms of its technical thoroughness.

However, in July 1982 the B.C. government chose to endorse the Dome Western LNG Project proposed for Grassy Point and during the fall of 1983 the National Energy Board held hearings on Dome's application for a facilities permit. Since 1982 the demand for natural gas has softened considerably and prices have consequently dropped, bringing into question the economic feasibility of proposed natural gas projects, including Dome's. Another actor, Chieftain Resources has indicated an interest in developing an LNG facility on Vancouver Island near Port Alberni. Due to the uncertainty of future events regarding natural gas demand and the feasibility of an LNG project becoming a reality on the west coast, the RIM GAS Project has taken on a "wait and see position" and, given the right circumstances, could once again become a dominant actor.

DISCUSSION AND CONCLUSIONS

There have been few formal site selection studies undertaken for hydrocarbon facilities in Canada. Proponents of hydrocarbon facilities, regulators and the public have only recently recognized the role of formal site selection in environmental management. The practice of site selection is evolving and each new siting exercise provides an opportunity to refine the techniques used. From its experience in three site selection studies, Petro-Canada has learned that a comprehensive siting study during the early stages of energy project development is an effective tool for integrating environmental, social, and safety concerns with engineering and economic considerations into project design and development. In addition, the studies have addressed regulatory requirements and facilitated public understanding of hydrocarbon projects.

The main elements of the approach to siting described in this paper during the Rim Gas Project site selection study are the following:

1) An interdisciplinary team of engineers, economists, environmental scientists, social scientists, decision analysts, and project management.
2) A commitment to address each of the five areas of general concern: environmental impact, health and safety, economics, and public attitude.

3) A commitment to communicate with the regulatory bodies and the public throughout the site selection study, thereby using their input and criticism to improve quality of the study.
4) A rigorous but simple methodology for integrating, filtering, and evaluating information needed to make a comparison among alternative sites.
5) A perspective that the selection of the site is an important part of the regulatory and project development process.

The methodology used in any siting study should enhance all of these elements. To do this, it must provide a guide for a systematic analysis of the project. Currently, the most appropriate approach is based on decision analysis concepts and suggests the following steps:

1) site identification
2) site screening
3) definition of indicators of impact
4) description of potential impacts in terms of indicators
5) evaluation of the relative importance of indicators (weighting)
6) comparison of site based on the evaluation of indicators
7) sensitivity analysis of results

Site identification and screening are essential to limit the analysis to a tractable number of sites. Careful definition of indicators focuses the analysis and guides the data collection and information processing needed to provide a description of potential impacts. Evaluation of the relative importance of indicators identifies critical issues and suggests priorities for further impact studies. Although the site comparison provides a rationale for the preferred site, the sensitivity analysis is often more important. It suggests the way in which the results of the site selection might change, should values or priorities shift or the assessment of impact prove inaccurate.

The most important conclusion that emerges from a review of the RIM GAS Project site selection study is that although the documentation of the analysis is essential, it is the process of conducting the site selection that has the greatest benefit. The site selection process, as it was used by RIM GAS Project management, has been an integral part of the overall project design and development. The site selection provided a vehicle for making environmental, social, and safety concerns equal in importance to engineering and economic considerations in the early stages of project design and throughout project development. The critical evaluation of a number of sites has provided a defensible rationale for the selection of the preferred site that has been used as a justification within the corporation and can be used as a justification to regulatory agencies. By providing the opportunity to look at the project in total, the site selection process has allowed project management to adapt and change priorities as the project evolves.

These far reaching benefits make the site selection process a valuable tool for the design, development and management of industrial projects.

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BURNTWOOD RIVER ENVIRONMENTAL OVERVIEW STUDY

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J.E. Callum, P. Eng., Study Manager, Manitoba Hydro
C.F. Osler, President, InterGroup Consulting Economists Ltd.

ABSTRACT

This paper reviews the significant features of a major multidisciplinary study of proposed hydro-electric development carried out over a three-year period. The objective of the study was to examine all relevant environmental, socio-economic, as well as economic and technical factors for the various alternatives for hydro-electric development of the Burntwood River in northern Manitoba and to select a preferred development plan. The study was unique in the following respects; (i) its purpose was to secure general acceptance of a development plan from all affected interest groups prior to detailed engineering and environmental work; (ii) its approach and analytical organization differed significantly from the usual impact assessment study; (iii) it was designed to permit major ongoing inputs from all affected interest groups. While the study did not select one preferred plan, it did identify several options for first development and the study approach was effective in providing a forum for discussion of options, impacts and issues with regulatory agencies and affected interest groups.

INTRODUCTION

The Churchill River, which originates in Alberta, flows through northern Saskatchewan and Manitoba and into Hudson Bay. In 1976, Manitoba Hydro completed a project, known as the Churchill River Diversion, which permits Manitoba Hydro under an Interim License, granted by the Province of Manitoba, to divert up to 30,000 cfs (850 cubic metres per second) of the flow from the Churchill River into the Rat River and subsequently into the Burntwood and Nelson rivers. The historical flow of the Burntwood River at Thompson varied from 210 cfs (6 cubic metres per second) to 16,400 cfs (464 cubic metres per second) and averaged 4,000 cfs (113 cubic metres per second). With this increase in flows, this project created significant impacts on the physical environment of the Burntwood River, many of which are in the process of evolution. This diversion and other related hydro-electric projects created considerable controversy between native organizations and communities, Manitoba Hydro, federal and provincial governments. This controversy led to the formation of the Northern Flood Committee, a legal entity composed of five Indian Bands from northern Manitoba, which negotiated the Northern Flood Agreement with Manitoba Hydro, the Province of Manitoba, and the Government of Canada. This Agreement specified mitigation measures for these projects and provided certain protection to the Bands in the planning of future projects.

The Diversion also makes possible the generation of approximately 700 MW of power along the Burntwood River at current flows of 30,000 cfs (850 cubic metres per second) and correspondingly more generation at higher diversion flows. Manitoba Hydro has determined that Burntwood River hydro-electric power may represent an economic alternative to projects on the lower Nelson River under certain foreseeable domestic load growth and/or export scenarios.

The historical problem with development on this river has been the "environmental sensitivity" of some of these options and the numerous alternative options.

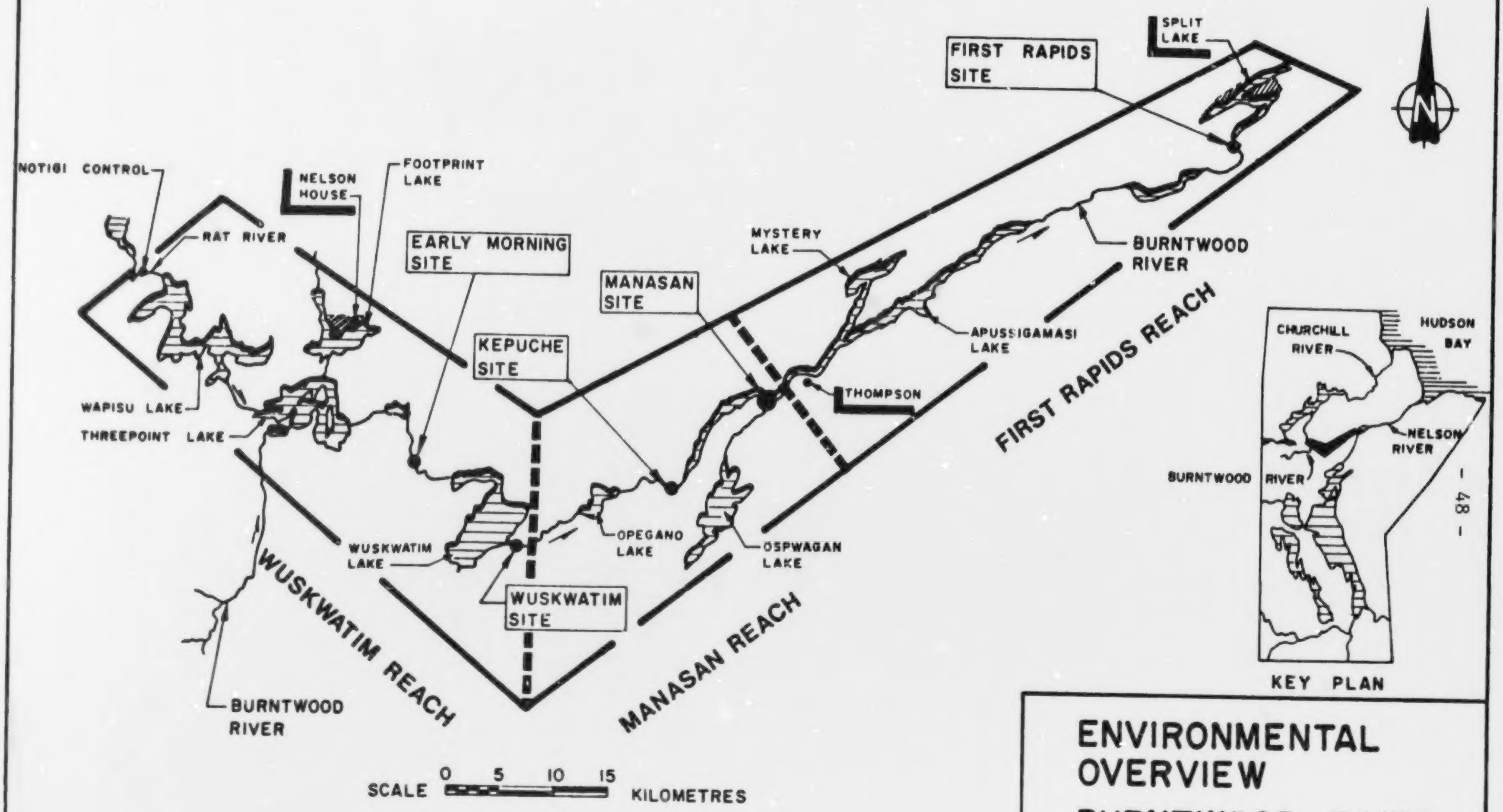
In 1977, the Honourable G.E. Tritschler was appointed by the provincial government as a Commissioner to make an inquiry into various aspects of Manitoba Hydro's northern hydro-electric developments. The December, 1979 Final Report of the Commission stated "Burntwood River plants, although perceived to be economic alternatives to lower Nelson development, remain unavailable for commitment as they have not been adequately studied". The Commission in this report recommended that Hydro should: "(i) recognize the essential equivalence of the engineering, financial, socio-economic and environmental aspects in the process of defining objective criteria and design parameters for its projects and programs, etc.". This recommendation highlighted the need for Manitoba Hydro, early in its generation planning process, to establish that potential development options, should be examined in a broader public interest perspective than was the case in the 1970s. The previous approach resulted in Manitoba Hydro incurring significant additional costs in project modifications after planning activities were thought to be completed and indeed, in some cases, construction had commenced. In order to avoid this type of situation re-occurring in the future, Manitoba Hydro decided to attempt to resolve major issues with relevant interest groups, including government, prior to project commitment.

In 1980, when this study commenced, the earliest possible in-service date for Burntwood power was forecast as 1989, implying a construction start-up in 1983 or 1984. Since then, load growth estimates have been revised downward and the earliest required in-service date for a Burntwood generating station will be 1992, with the most likely timing to be in the late 1990s. Given the long lead times required to plan and construct new hydro-electric generating capacity, however, this delay has not altered the need to evolve an appropriate plan for Burntwood development.

During construction of the Churchill River Diversion, Manitoba Hydro entered into two agreements which influence the operations of the Burntwood River System. These two agreements, one with the City of Thompson and the other with the Northern Flood Committee, plus the Interim License, represent contractual and regulatory constraints to the operation of the existing Diversion works and may influence the development of the river.

Four communities exist in the study area: Thompson, Nelson House, Split Lake and York Landing. Thompson (population 16,000) is primarily a one-industry mining centre which is a major supply centre for northern Manitoba, while Nelson House, Split Lake and York Landing (population each less than 2,000) are typical of such predominantly native communities in the north. Five potential sites for hydro-electric development exist in the river system. With various forebay elevations and other relevant considerations, twelve development options emerged.

This study was intended to examine all relevant environmental, socio-economic as well as economic and technical factors for various alternatives of river development in order to select a preferred Burntwood River hydro-electric development plan(s). It examined the effects of a specific set of alternatives for reservoir development along the Burntwood River river system and identified and evaluated likely future environmental and socio-economic effects of these alternatives within the study area depicted in Figure 1.


SPLIT LAKE
FIRST RAPIDS SITE
NOTIGI CONTROL
NELSON HOUSE
FOOTPRINT LAKE
RAT RIVER
EARLY MORNING SITE
MYSTERY LAKE
BURNTWOOD RIVER
MANASAN SITE
KEPUCHE SITE
APUSSIGAMASI LAKE
FIRST RAPIDS REACH
THOMPSON
WAPISU LAKE
THREEPOINT LAKE
WUSKWATIM LAKE
OPEGANO LAKE
OSPWAGAN LAKE
WUSKWATIM SITE
WUSKWATIM REACH
MANASAN REACH
BURNTWOOD RIVER
SCALE 0 5 10 15 KILOMETRES
N
CHURCHILL RIVER
HUDSON BAY
NELSON RIVER
BURNTWOOD RIVER
KEY PLAN

ENVIRONMENTAL OVERVIEW
BURNTWOOD RIVER SYSTEM
STUDY AREA

FIG. 1

By involving and co-operating with government regulatory agencies and other affected parties throughout the study, Manitoba Hydro sought understanding and approval of the screening process and the choice of preferred project alternatives. More importantly, Manitoba Hydro sought and received government participation in the decision-making process throughout the study which enabled mutual agreement to exclude less desirable options from further planning activity.

Studies of this type traditionally have not been part of Manitoba Hydro's generation planning process. However, with greater concern about environmental and socio-economic issues on the part of both the general public and specific interest groups, Manitoba Hydro recognized the benefits that inclusion of such a study at this stage of the generation planning process can provide.

This study was directed by the Environmental Services Department of Manitoba Hydro. The study was conducted by an association of MacLaren Engineers Inc. and InterGroup Consulting Economists Ltd., known as MacLaren/InterGroup. The study team was divided into three components, environmental, natural resource and socio-economic studies, each with a co-ordinator. The study team management included a Director, Deputy Director and Advisor. The study, which commenced in 1980, was completed in 1983, and a final report with supporting technical appendices was issued in January 1984.

GENERAL APPROACH

The general study approach involved assessment of each of the options with respect to environmental and socio-economic issues and then ranking of the options in order of desirability, based on the identified issues relevant to the selection of options. Since ranking could depend, at least in part, on value judgments which might differ among interest groups, the study methodology specifically allowed for consideration of both objective and judgmental factors by a number of different groups. The best option(s) in each reach were further subjected to evaluations as part of an entire river development plan, the confirmation of which was the recommended preferred river development plans.

This approach was "issue-oriented" rather than aimed at assessing an all-inclusive checklist of potential environmental or socio-economic impacts. The latter approach was considered more appropriate for a detailed environmental impact study. Using this approach, the study team focused on key issues identified by Manitoba Hydro, government agencies, and members of the potentially-affected public as well as by the study team itself. The analysis of the key issues determined the acceptability of each project option as well as the ranking of the various options.

In essence, the approach was oriented towards the comparison of options with the objective of achieving agreement on the selection of the most desirable options. The approach was also people-oriented. It began with the people likely to be affected rather than the natural environments or resources. The study team sought to identify who is likely to be affected, how, where and to what extent, by the various development options. This in turn led to analyses of the relevant resource activities (e.g., fishing) and communities. Subsequent studies of the physical and biological environments (e.g., fish, habitat) were designed primarily to deal with the issues of concern to people living and working in the study area or of concern to the regulatory agencies.

STUDY PROCESS AND PHASES

The study was organized into four phases to (i) facilitate the analysis of key issues to ensure the study was addressing the most relevant concerns, (ii) assist in the progressive screening of options, and (iii) facilitate discussion with Manitoba Hydro, government and potentially affected interest groups. The technical activities and studies in each phase were described in status reports, which were issued as a focus for the liaison activities. The study plan (Figure 2) shows the inter-relationship between the technical studies and the liaison activities.

Phase I - Project Description and Issue Identification

Phase I included the description of relevant options, the delineation of the issues which required study and the development of a detailed study plan. Two status reports were issued during Phase I to external groups.

Phase II - Initial Ranking of Options

Phase II provided a preliminary ranking of options and an examination of engineering, environmental, socio-economic and economic impacts under the categories of monetary and non-monetary impacts. Two status reports were issued to external groups during this phase.

Phase III - Preferred Development Plans

Phase III assessed preferred development plans for the integrated river system and examined issues related to the selection of project options, and the order of option development along the river under various flow conditions. One status report was issued to external groups during this phase.

Phase IV - Final Report and Documentation

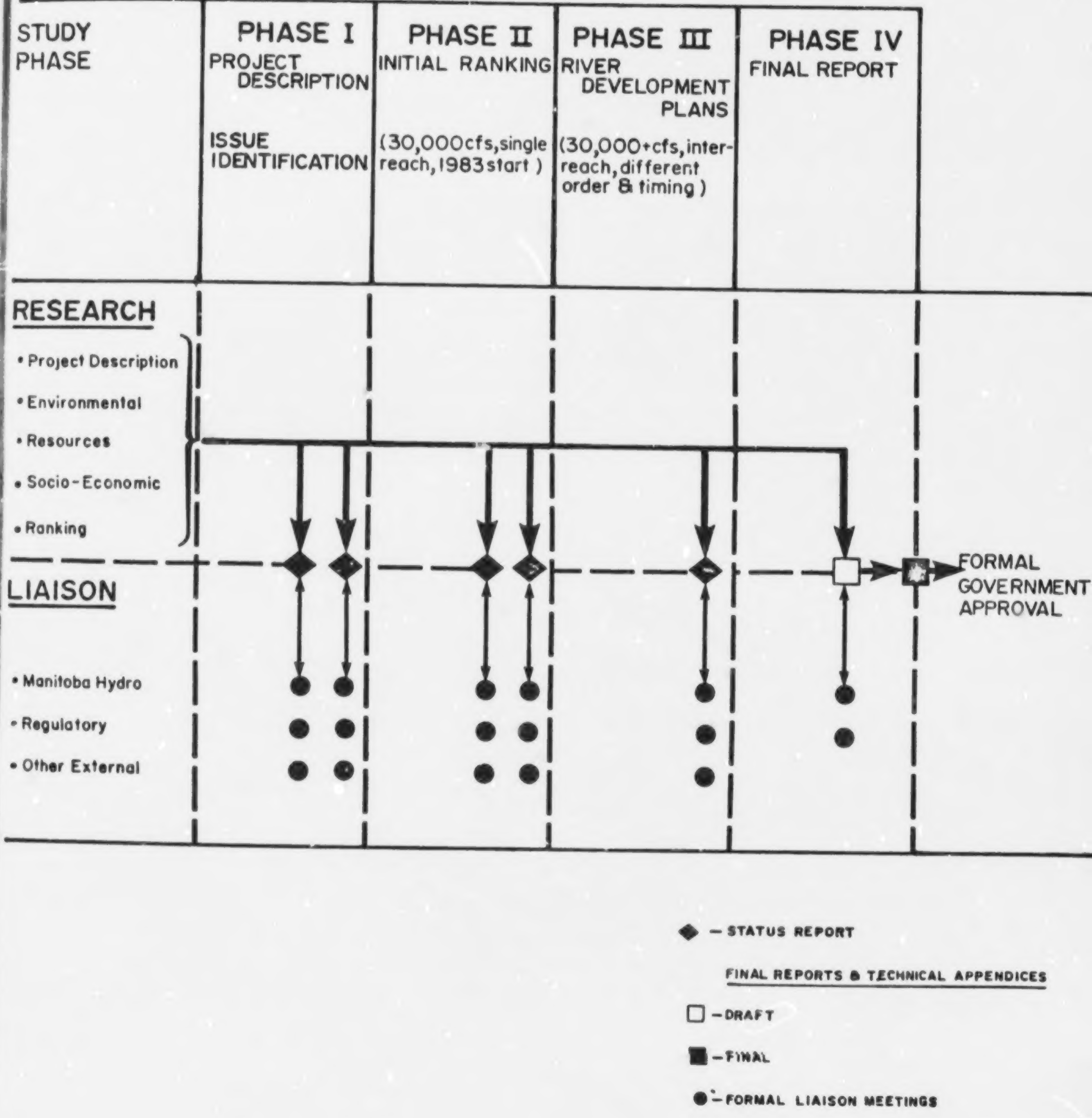
Phase IV included a review of the Phase III conclusions with external groups and a review of the final report and its supporting appendices with the Technical Advisory Committee of the Government regulatory agencies.

LIAISON PROCESS

At the commencement of the study, Manitoba Hydro issued a press release which indicated the purpose of the study and intention of the study team and Manitoba Hydro to invite input from and discussion with potentially affected interest groups.

As mentioned earlier in this paper, liaison with government departments and directly-affected interest groups was an important aspect of this study. The study plan allocated a significant portion of the study cost to this activity. The purpose of this activity, which occurred at scheduled points in the study as indicated in Figure 2, was: (1) to test the reaction to the Study Team's recommendation for deletion of specific options; and (2) to obtain the input of government and the public interest groups early in the study to minimize the risk of surprises occurring late in the study.

During the study five status reports were issued and discussions held with the following groups about issues raised by the study approach, analysis and conclusions:


STUDY PHASE
PHASE I
PROJECT DESCRIPTION
ISSUE IDENTIFICATION
PHASE II
INITIAL RANKING
(30,000cfs, single reach, 1983 start)
PHASE III
RIVER DEVELOPMENT PLANS
(30,000+cfs, inter-reach, different order & timing)
PHASE IV
FINAL REPORT
RESEARCH
• Project Description
• Environmental
• Resources
• Socio-Economic
• Ranking
LIAISON
• Manitoba Hydro
• Regulatory
• Other External
FORMAL GOVERNMENT APPROVAL
◆ – STATUS REPORT
FINAL REPORTS & TECHNICAL APPENDICES
☐ – DRAFT
■ – FINAL
● – FORMAL LIAISON MEETINGS

STUDY PLAN

Figure. 2

- The Manitoba Government as represented by a Technical Advisory Committee (TAC) of Manitoba Environmental Assessment and Review Agency (MEARA), Interdepartmental Planning Board (IPB);
- The Government of Canada as represented by its informal participation in TAC meetings through representatives from DIAND, FAO, and Environmental Canada;
- The City of Thompson;
- The Local Government District of Mystery Lake;
- Inco Limited;
- The Indian Band Councils of Split Lake and York Factory (located at York Landing);
- The non-status Indian Community of Nelson House.

Copies of the status report were provided to the following groups and discussion was invited but did not take place:

- The Indian Band Council of Nelson House;
- The Northern Flood Committee (which includes representation of the Indian Bands of Nelson House, Split Lake and York Factory);
- The Four Nations Confederacy (Manitoba Indian Brotherhood); and
- The Manitoba Metis Federation.

The majority of the above groups welcomed the opportunity to participate in the study and useful dialogue took place. The inputs received from these groups had an influence on the activities in later phases of the study.

It was unfortunate from the standpoint of the study team and Manitoba Hydro that the Nelson House Band Council, whose community could be affected by several of the options and the Northern Flood Committee (NFC) decided not to participate in the study. It was their view that this study was premature in that many of their claims from the Churchill River Diversion Project were still unresolved at the time of their decision (1980) and that any participation may prejudice their future entitlements. The NFC took the position early in the study; they would not encourage the Indian Bands signatory to the Northern Flood Agreement to participate in the study. Limited discussion took place with the Split Lake and York Factory Indian Bands, at their request, but not with the Nelson House Band.

IDENTIFICATION OF ISSUES AND OPTIONS (Phase I)

The first steps in conducting this multidisciplinary planning exercise were to determine the hydro generation options on the Burntwood System to be assessed and to establish a framework for assessing these options based on an initial identification of issues related to the potential effects that hydro power development could have on the environment, use of natural resources, economic and social conditions in the Study Area. These activities occurred concurrently in Phase I of the study and were reported in the Phase I Status Report.

Option Identification and Project Description

Specific project description details were assembled from an array of generation sites and associated forebay elevations which previously had been identified by Manitoba Hydro. The utility had conducted feasibility studies on five potential generating sites, each with various forebay elevations. The degree of detail varied greatly with each alternative. The variability of the quality of information posed many difficulties throughout the study, particularly when it came to assessing the relative merits of options and arriving at conclusions regarding the deletion of options.

The outcome of this task was the definition of ten project options incorporating site and forebay elevations which were to be assessed and compared in Phases II and III. During the course of these phases, two further options were added and the elevation of one of the original options was modified. The resulting twelve options used in the study are presented in Table 1 with selected information on their characteristics. The generating capacity of the options ranged from 155 to 300 megawatts, capital cost from $193 to $392 million (1980 dollars) and the incremental flooded area from essentially none to one hundred square miles (161 square kilometres).

TABLE 1
OPTIONS STUDIED - SELECTED CHARACTERISTICS

River Reach / Option	Mean Annual Head	Installed Capacity	Annual Mean Energy	New Flooded Area	New Shoreline Length	Estimated Capital Cost
	(feet)	(MW)	(GWh)	(sq.mi.)	(miles)	($ 1980 million)
FIRST RAPIDS 616-620	64	170	1 150	22	228	253
MANASAN 690	68	180	1 250	41	275	251
MANASAN 700	78	200	1 400	57	265	286
KEPUCHE 710	58	155	1 050	5	60	193
MANASAN 650/KEPUCHE 710	86	230	1 550	5	60	367
WUSKWATIM 770	70	180	1 250	0	0	217
WUSKWATIM 800 a)	80	260	1 450	58	783	275
WUSKWATIM 800 b)	100	260	1 850	58	783	275
WUSKWATIM 810	107	285	1 950	100	920	320
WUSKWATIM 770/EARLY MORNING 800 a)	88	270	1 600	17	488	367
WUSKWATIM 770/EARLY MORNING 800 b)	92	270	1 700	17	488	367
WUSKWATIM 770/EARLY MORNING 810	96	300	1 750	32	597	392

To facilitate analysis and comparison, the options were subdivided into three groups along reaches of the Burntwood River, i.e., the First Rapids, Manasan and Wuskwatim Reaches as shown in Figure 1. Each reach contained one or more options, of which only one could be developed in that reach.

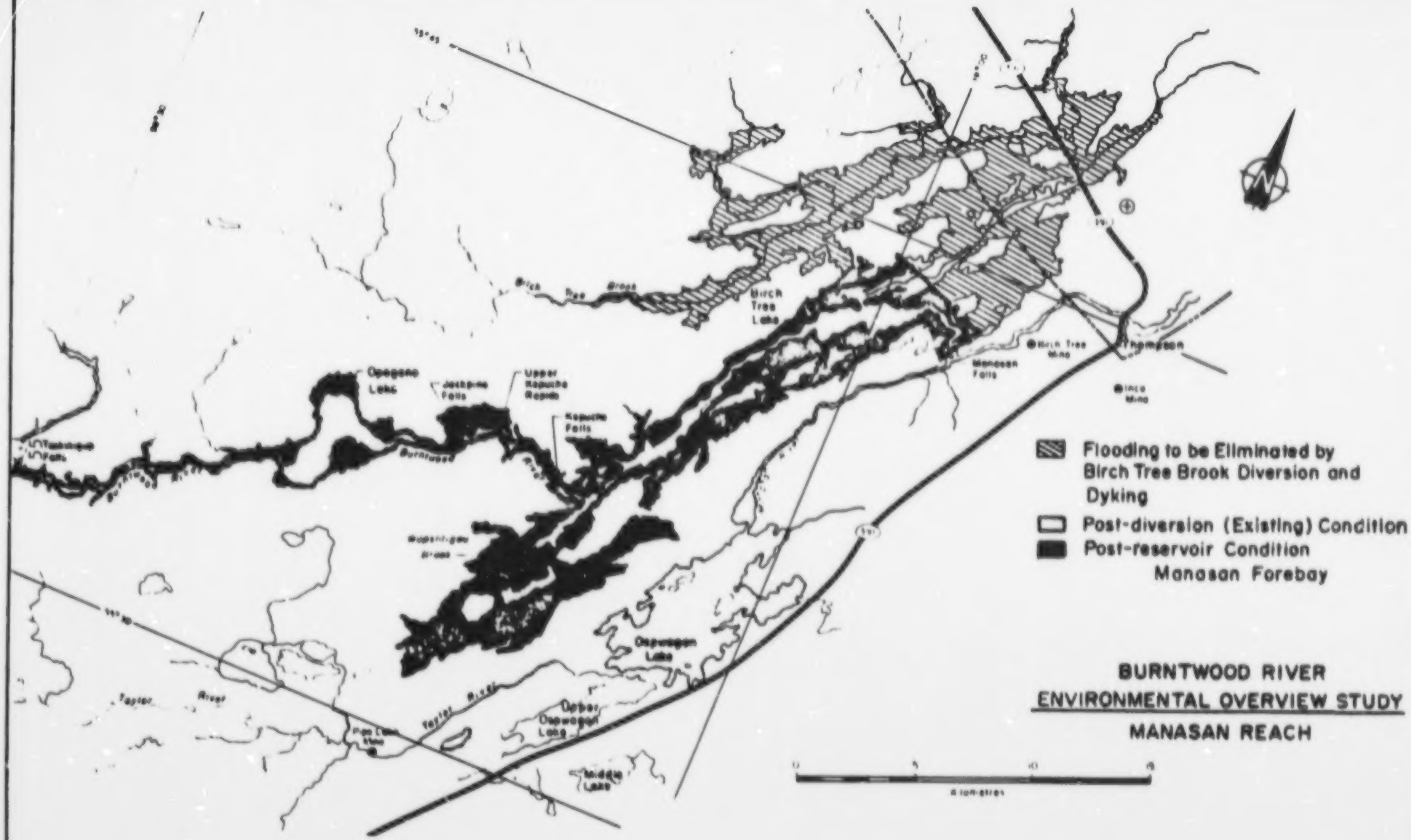
The Northern Flood Agreement constrained development of power from the Wuskwatim reach options through water level limitations at Nelson House that restrict forebay elevations at these sites. The interpretation and impact of this constraint was a key dimension of the study. To address it, options were included for this reach that involved flooding and no flooding and that were within and outside of the present terms of the Agreement. The two new options added in Phase II were incorporated to respond to the different interpretations of the Agreement.

For each option, a project description was prepared covering relevant information about energy production, site description, physical components, capital costs, operating parameters, river flows, flooding, stage discharge, ice regimes, manpower, materials, purchase requirements and socio-economic policies. Initial information that could be taken from available Hydro reports was developed in Phase I as part of the option identification process. Further more extensive and refined descriptions were prepared in Phase II and to a very limited extent in Phase III. Much of the information for Phases II and III had to be specially developed by Hydro officials in response to study team requests. A key, and often very difficult, aspect of the project description studies was assembling and translating physical, hydrological and cost estimation information that Hydro engineers typically work with into a form suitable for use in the various interdisciplinary study components. A good example of this is the flooding information. Estimates of amount of flooded area and maps of flooded areas had to be derived for each option from a variety of information sources including hydrologic information supplied by Hydro and detailed forest inventory maps. Adjustments had to be made to the information supplied to net out the areas previously flooded by the Churchill River Diversion as this had not been taken into account in much of the information originally available. A flooded area map developed in the study for the Manasan 700 and Kepuche 710 options is shown in Figure 3.

Issue Identification

Issues of potential concern to local residents, regulatory groups and Manitoba Hydro were identified on the basis of a review of relevant literature and the experience of consulting team members. Emphasis was placed on identifying issues that (a) affected local people as opposed, for example, to those that might affect terrain or birds, (b) would be relevant to the comparison of alternatives, i.e., issues whose effects would show some variation among options. This process led to the identification of over fifty issues which were then grouped into categories for purposes of analysis and presentation. The issues covered environmental, resource use, economic, social and power value topics.

The categories for the issues reflected the general methodology and framework for analysis of individual options and for comparing options. As a first categorization, the issues were divided into those that were amenable to monetary analysis and those that were not. The study team recognized the advantages of using monetary analysis to the maximum extent possible because of its suitability for comparing options. With monetary analysis, many effects produced by an option can be reduced to a single value that can readily be compared to similarly developed values for other options. At the same time, there were many very relevant effects not amenable to translation in monetary terms, e.g., strains on community services, socio-cultural changes, flooding of archaeological sites. These had to be considered and analyzed either in quantitative terms using non-monetary measures, e.g., number of archaeological sites flooded, or in qualitative terms, e.g., change in social conditions in a native community. Non-monetary issues require value judgments in making comparisons of options. Such judgments are necessary to compare monetary with non-monetary results in


Opegano Lake
Jackpine Falls
Upper Kepuche Rapids
Kepuche Falls
Taskinigup Falls
Burntwood River
Birch Tree Brook
Birch Tree Lake
Manasan Falls
Birch Tree Mine
Thompson
Inco Mine
Opswagan Lake
Upper Opswagan Lake
Middle Lake
Taylor River
391
▨ Flooding to be Eliminated by Birch Tree Brook Diversion and Dyking
☐ Post-diversion (Existing) Condition
■ Post-reservoir Condition Manasan Forebay
0
5
10
15
Kilometres

BURNTWOOD RIVER
ENVIRONMENTAL OVERVIEW STUDY
MANASAN REACH

Figure 3

general and also among various non-monetary categories. The development of an appropriate approach to enable comparison and ranking of options in the context of monetary and non-monetary analysis received a great deal of attention in Phase I and Phase II of the study.

Within the monetary and non-monetary categories, additional sub-categories were established reflecting the nature of the issues or effects being analyzed.

ASSESSMENT AND SCREENING OF OPTIONS (Phases II and III)

The major part of the study involved assessing the effects of the twelve development options and then comparing them with a view to eliminating some from further consideration and to determining which site to develop first. This took place in two steps during Phases II and III.

Phase II

The effects of each of the project options were assessed in Phase II, followed by a comparison and screening of options within each of the three reaches. Environmental, resource, socio-economic and power value studies were carried out to analyze the monetary and non-monetary impacts of each option and results of the analysis were presented for the categories noted previously. This usually involved a process of obtaining relevant project description information, identifying and assessing the current and projected situation without development, reviewing relevant previous experience and combining the previous items to estimate impacts. The study was fortunate to have significant relevant previous experience to draw from in terms of several hydro development projects that had occurred in northern Manitoba in the 1970s.

Monetary effects, which are summarized for all options in Table 2, were presented as net estimates of benefits and costs. This meant that any benefits or income produced were adjusted to take into account costs incurred from achieving them, including any gains that would otherwise have occurred without the development. All monetary estimates were presented in 1980 present values using discount rates ranging from 3% to 10%. Project and other capital costs were expressed in 1980 dollars. Non-monetary effects were presented in quantitative and qualitative terms, depending on what the type of issue warranted or the data permitted.

Each option was assessed assuming a 1983 arbitrary construction start, first power production in 1989 and without regard to interdependent effects among options. Analysis in this pahse was limited to an assumption of a constant 30,000 cubic feet per second base flow.

It was found that monetary impacts varied significantly among the project options examined and were heavily influenced by the following:

- power benefits (amount of power generated, value of power, and capital cost of the option);
- employment and business opportunities (accrue chiefly during the construction period and relate somewhat to the capital cost of the option);
- resource costs (vary with the flooded area and the extent of the use of the natural resources in the flooded area);
- infrastructure costs (impacts are site-specific and vary with the extent of human activity in the area).

As shown in Table 2, the monetary assessment indicated that power benefits and employment and business impacts dominate monetary comparisons. Resource and infrastructure costs were very small relative to the power, employment and business effects, accounting for between zero and two per cent of total monetary net benefits.

TABLE 2

SUMMARY OF MONETARY BENEFITS - ALL OPTIONS
CONSTRUCTION AND OPERATIONS
PRESENT VALUE OF MONETARY BENEFITS
DISCOUNTED AT 6% ($ million 1980)

Site and Elevation	Power[1] Benefits	Employment & Business Benefits	Resource & Infra. Costs	Total Monetary Net Benefits	Monetary Ranking Within Reach
FIRST RAPIDS 616-620	36.3	31.5	(0.6)	67.2	1
MANASAN 690	59.0	25.8	(negligible)	85.6	2
MANASAN 700[2]	49.0	28.2	(negligible)	77.2	4
MANASAN 650/KEPUCHE 710	35.6	39.1	--	74.7	3
KEPUCHE 710	63.8	22.8	--	86.6	1
WUSKWATIM 770	86.0	22.2	--	108.2	3
WUSKWATIM 800 a)[2]	82.4	25.6	(0.6)	107.4	4
WUSKWATIM 800 b)	164.0	25.6	(0.6)	189.0	1
WUSKWATIM 810	152.1	27.7	(1.6)	178.2	2
WUSKWATIM 770/EARLY MORNING 800 a)[2]	45.4	37.3	(0.4)	82.3	7
WUSKWATIM 770/EARLY MORNING 800 b)[2]	64.9	37.3	(0.4)	101.8	5
WUSKWATIM 770/EARLY MORNING 810	56.6	38.9	(1.1)	94.4	6

( ) denotes negative value.

[1] Total benefits less total costs of construction, operation and maintenance.

[2] Denotes development options recommended to be deleted.

Assessment of non-monetary issues depended upon values assigned to the different factors, and these varied among different observers. In general, employment and business effects were considered to be beneficial while flooding effects were considered to be detrimental. Non-monetary issues were identified as especially important in the selection of a preferred option on the Wuskwatim Reach.

The following outlines some of the major non-monetary impacts related to flooding after the project has been constructed.

- Flooding will disrupt local fishing, trapping, and certain recreational activities. In the longer term, with the stabilization of the modified regime, reservoirs may enhance local fishing and recreational opportunities. Higher levels of mercury in fish are forecast with inundation of new shorelines; however, these will have impacts on fisheries in the short term but are expected to deline in the long term.
- Reservoirs will stabilize water levels, reduce stream erosion and ice build-up at rapids, and improve flow management on the river with varying flows.
- Reservoirs will reduce existing stream erosion but will cause new shorelines and associated erosion and increases in suspended solids.
- Flooding will affect local aesthetics.
- Reservoirs will flood archaeological and/or cultural sites.

Development would also create increased employment and business opportunities for the local region, particularly during construction. The magnitude and nature of these impacts is sensitive to the mitigation and enhancement policies adopted, e.g., specific policy measures are required to encourage use of local native employees and businesses. It was observed that these projects would accelerate native community transition to an industrial society, and that this transition was associated with various problems and disruptive effects. On balance, the majority of parties participating in the study considered it desirable to encourage both the development of these hydro-electric resources and the maximum feasible involvement of local native groups.

As a result of Phase II analysis and liaison, six options (one in the Manasan Reach and five in the Wuskwatim Reach) were eliminated from further consideration, using the ranking and screening procedure described later in this presentation.

Phase III

Phase III analysis evaluated the ranking and selection of preferred river development plans in terms of the six remaining options. For the purpose of this study, a River Development Plan (RDP) was defined to incorporate three variables:

- Project sites in all reaches of the river. This variable introduced a new factor for Phase III analysis, namely, the impacts of inter-reach development; it also focused attention on how many reaches to develop and which site to develop in each reach.
- Order of development of sites along the river. Of particular importance here was the question of which reach and which site to develop first.
- Timing of development of sites along the river. The timing variable focuses explicitly on the different impacts associated with the following three timing cases -- concurrent development, overlapping development or delayed development of sites in the plan.

In addition, Phase III analysis also assessed the extent to which ranking of RDPs is affected by:

- different levels of diversion flow;
- mitigation or enhancement measures related to site options, order of development, timing of development, modes of system operation and overall socio-economic development (including jobs and business development).

These, along with an energy interdependency for the Kepuche site, arising from backwater implications on the Wuskwatim options, were particularly important in influencing the further elimination of options in the Manasan reach.

With the few important and easily identified exceptions, it was determined that the overall RDP impacts were, in fact, the sum of the impacts of the individual site options identified during Phase II. This meant that the study team could confidently assess site, order and timing issues independently without fear of overlooking significant inter-reach interdependencies. Monetary and non-monetary assessments of various individual or combined options were prepared as appropriate to evaluate each issue. An example of the type of information developed to assess these issues is shown in Figure 4, which illustrates the implications of alternative timing choices on employment requirements. The information in this figure was used to assess the relative attractiveness of alternative timing scenarios of a three site development on local training and employment opportunities and to derive effects on local population growth and associated incremental demands for community services. Using this and other information, "overlapping" development, in which there was a three to five year difference in the starting date for construction of each successive Burntwood site, was found to be the preferred timing approach.

Although it was originally intended to arrive at a single option in each reach of the river and a preferred sequence for their development, it was concluded that this would not be possible for several reasons:

- in the Wuskwatim reach, various technical issues require further studies, chiefly relating to options with forebays between 770 and 800, and to predicted post-development water level elevations under winter conditions;
- the feasibility of various mitigation works to improve channel capacity in the Wuskwatim reach needs further examination;
- there are important areas of uncertainty relating to contractual aspects of the Northern Flood Agreement which require clarification; resolution of these items may be expected to be time consuming.

In spite of this, Phase III was able to eliminate one of the remaining options in Manasan reach and to identify four options as possible first sites depending on the situation with the Northern Flood Agreement.

Ranking and Screening Methodology

The study ranking and screening of options was carried out in the following steps. This process was applied during Phase II to rank individual options within reaches and in Phase III to evaluate remaining options in terms of combinations among reaches, order of development and timing of development.

1) Estimate impacts for each option under each of the relevant monetary and non-monetary categories.
2) Complete monetary analysis to establish the net quantifiable effects in dollar terms of each option and rank these. The results of this step are presented in Table 2.
3) Determine which options, if any, are clearly dominated by other options, both in terms of net monetary effects and the various non-monetary impacts. This analysis was conducted only within each reach of the river during Phase II.
4) For the remaining non-dominated options, the study team identified the specific trade-offs between impact issues which were critical for determining ranking:
   - focusing on the non-monetary issues for each option, the extent to which

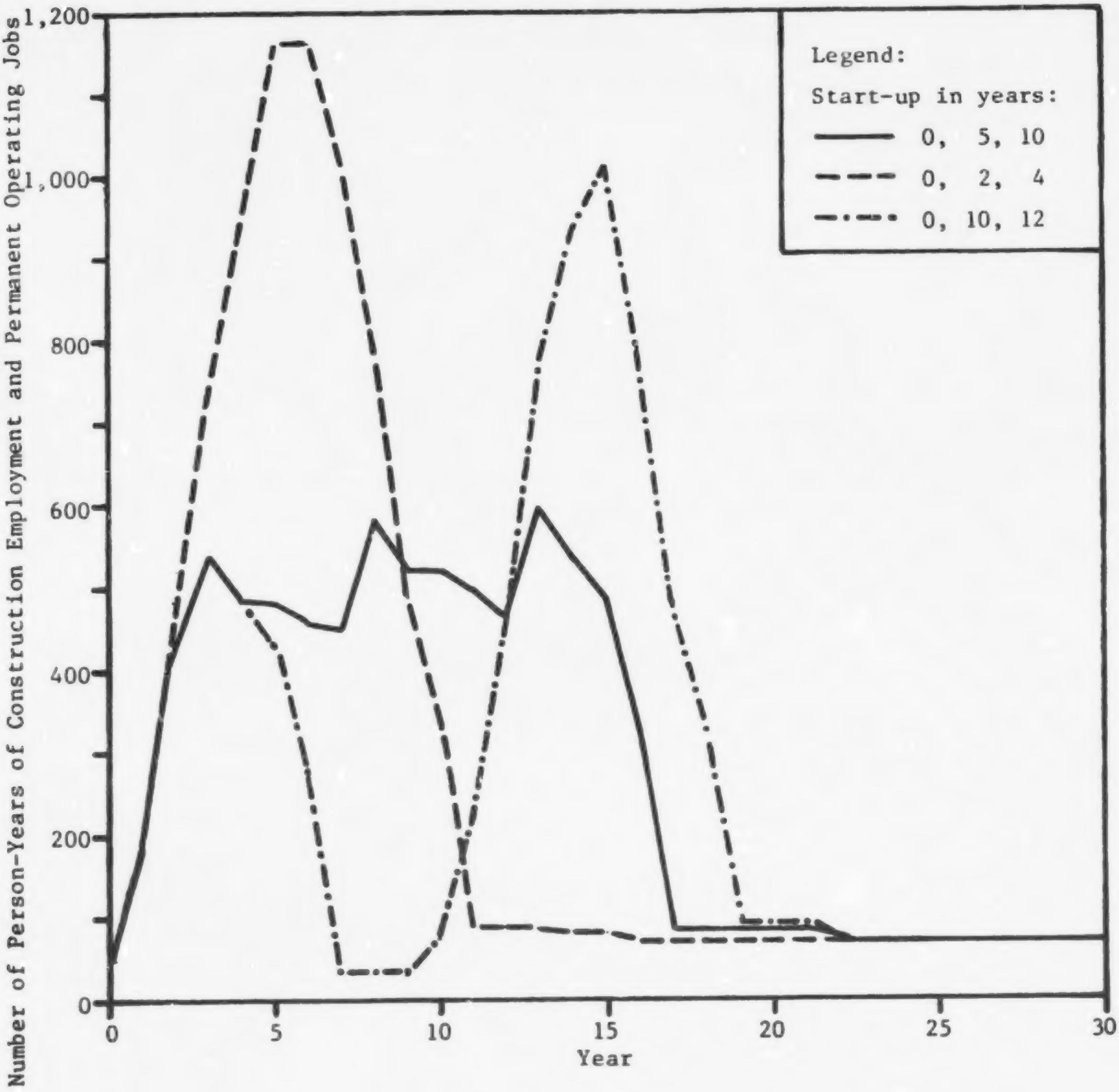


FIGURE 4

IMPLICATIONS OF ALTERNATIVE TIMING CHOICES ON EMPLOYMENT REQUIREMENTS[1/]

[1/] Based on RRDP site and order configuration of Wuskwatim 800 b), Manasan 695, First Rapids.

overall impacts are positive or negative was determined;
  - the trade-offs and value system choices which were likely to affect ranking of the options by the groups involved in the liaison process were identified.

5) The study team assessed the extent to which value judgments were likely to affect project ranking. Value judgments favouring different study area communities and notable interests such as Inco were considered.
6) The results of the ranking analyses were presented to the affected interest groups (as planned in the liaison process). Participating groups were presented with the following information:
   - study team estimates for each option on the magnitude of monetary and non-monetary impacts (by relevant resource and/or community group);
   - study team estimates of the overall net monetary impact for each option, and an initial ranking of options based on these net monetary impacts;
   - study team assessments of the extent to which non-monetary factors and value judgment differences could affect the ranking of options;
   - study team assessment, based on the above considerations of the ranking conclusions; these conclusions indicated the extent to which more than one ranking of the options merited serious consideration in light of differences in value judgments.
7) Discussion of ranking analysis took place with participating affected interest groups. This discussion focused on the ranking analyses presented by the study team, and on the ranking of options, but also examined the possibility that specific mitigation and/or enhancement measures would change ranking preference.

The option elimination process resulting from this procedure is shown in Table 3. Options eliminated in Phase II and Phase III are shown by reach along with those that remained at the end of the study.

TABLE 3

ELIMINATION OF OPTIONS

River Reach	Eliminated in Phase II	Eliminated in Phase III	Remaining at end of study
First Rapids			First Rapids 616
Manasan	Manasan 700 Manasan 650/Kepuche 710	Kepuche 710	Manasan 695
Wuskwatim	Wuskwatim 800 a) Wuskwatim 770/Early Morning 800 a) Wuskwatim 770/Early Morning 800 b) Wuskwatim/Early Morning 810		Wuskwatim 770-800 Wuskwatim 800 b) Wuskwatim 804

STUDY CONCLUSIONS

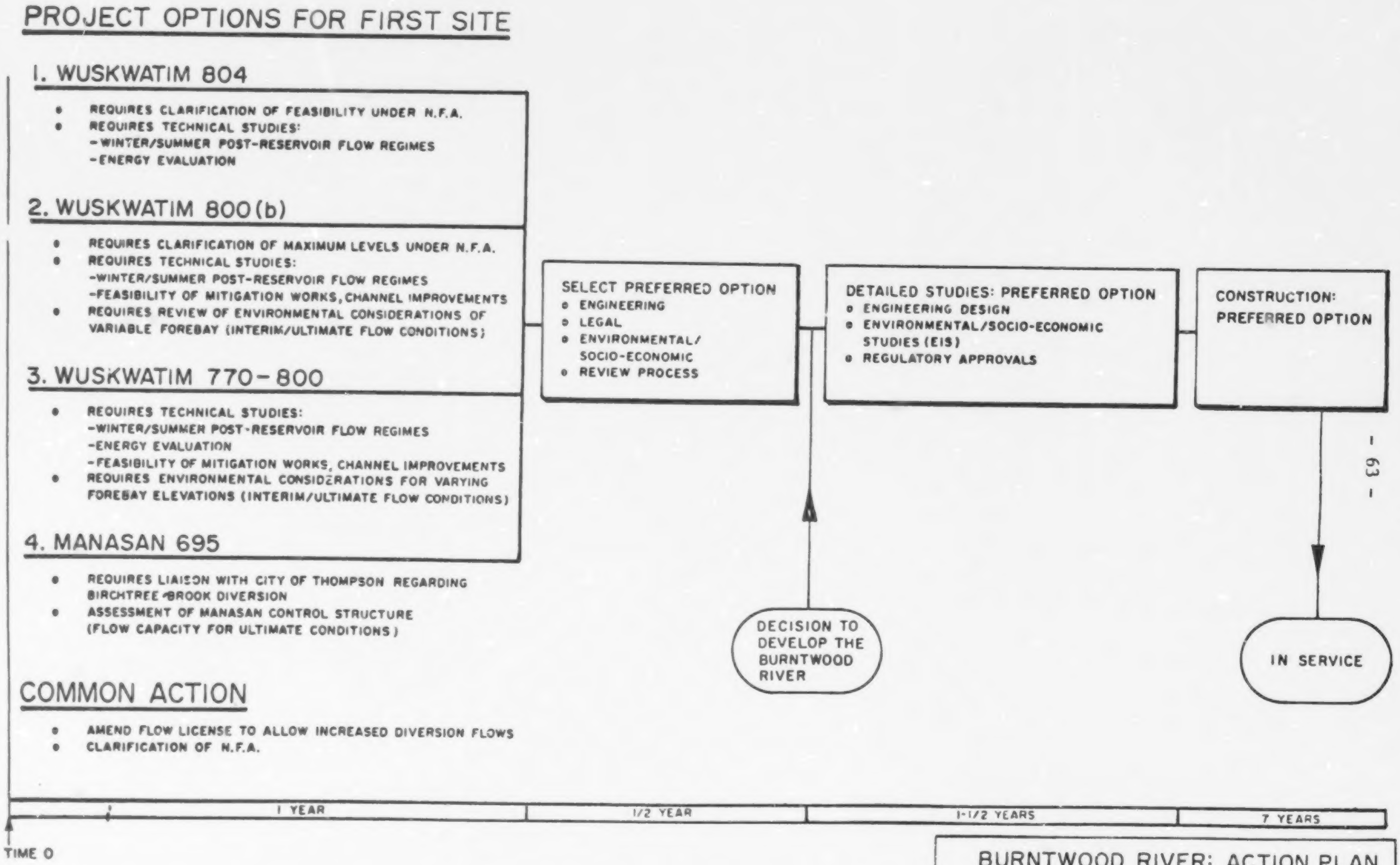
Study conclusions were based on the conclusions of Phases II and III. The key conclusions from these phases were compiled for approval by the Manitoba Government. The approval process from the provincial government is intended to proceed with reviews from the Technical Advisory Committee and other senior committees leading to formal cabinet approval. This review by senior government is now underway. To date, the first level of concurrence has been received from the Inter-departmental Technical Advisory Committee which was involved throughout the study.

The study conclusions are:

1) Deletion of the following Burntwood River site development options from further planning work in the foreseeable future:
   - Manasan 700
   - Manasan 650/Kepuche 700
   - Kepuche 710
   - Wuskwatim 800 a)
   - Wuskwatim 770/Early Morning 800 a)
   - Wuskwatim 770/Early Morning 800 b)
   - Wuskwatim 770/Early Morning 810.
2) The full development plan for the Burntwood River would include First Rapids 620, Manasan 695 (including the dyking and diversion of Birchtree Brook) and one of three options at the Wuskwatim site.
3) A key issue in planning for the future development of the Burntwood River is the selection of the first site to be constructed. While monetary considerations favour one of the three Wuskwatim options for the first site, it is not possible to identify a preferred first site at this time. The selection of the first site to be constructed on the Burntwood River will be determined by the following circumstances:
   - if the relevant issues in the Wuskwatim Reach related to the Northern Flood Agreement, technical uncertainties, and regulatory process are resolved in sufficient time to meet the in-service date for a Burntwood option, then the first site would be one of the following:
     - Wuskwatim 804
     - Wuskwatim 800 b)
     - Wuskwatim 770-800
   - if the relevant issues in the Wuskwatim Reach are not resolved in sufficient time to meet the required in-service date for a Burntwood option, the Manasan 695 option is the preferred alternative.
4) The plan of action shown on Figure 5 is appropriate to address the areas of uncertainty remaining with respect to the selection of the first site.
5) Additional environmental assessment of potential Burntwood River sites in the First Rapids and Manasan Reaches will not be required until such time as an environmental impact statement for a specific site option is required. Further studies as shown in plan of action (some of which are underway) are required in the Wuskwatim Reach to identify the preferred option.

OBSERVATIONS AND CONCLUSIONS

The Burntwood River Environmental Overview Study has achieved a significant integration of engineering, environmental and socio-economic considera-


PROJECT OPTIONS FOR FIRST SITE
1. WUSKWATIM 804
• REQUIRES CLARIFICATION OF FEASIBILITY UNDER N.F.A.
• REQUIRES TECHNICAL STUDIES:
-WINTER/SUMMER POST-RESERVOIR FLOW REGIMES
-ENERGY EVALUATION
2. WUSKWATIM 800(b)
• REQUIRES CLARIFICATION OF MAXIMUM LEVELS UNDER N.F.A.
• REQUIRES TECHNICAL STUDIES:
-WINTER/SUMMER POST-RESERVOIR FLOW REGIMES
-FEASIBILITY OF MITIGATION WORKS, CHANNEL IMPROVEMENTS
• REQUIRES REVIEW OF ENVIRONMENTAL CONSIDERATIONS OF VARIABLE FOREBAY (INTERIM/ULTIMATE FLOW CONDITIONS)
3. WUSKWATIM 770-800
• REQUIRES TECHNICAL STUDIES:
-WINTER/SUMMER POST-RESERVOIR FLOW REGIMES
-ENERGY EVALUATION
-FEASIBILITY OF MITIGATION WORKS, CHANNEL IMPROVEMENTS
• REQUIRES ENVIRONMENTAL CONSIDERATIONS FOR VARYING FOREBAY ELEVATIONS (INTERIM/ULTIMATE FLOW CONDITIONS)
4. MANASAN 695
• REQUIRES LIAISON WITH CITY OF THOMPSON REGARDING BIRCHTREE BROOK DIVERSION
• ASSESSMENT OF MANASAN CONTROL STRUCTURE (FLOW CAPACITY FOR ULTIMATE CONDITIONS)
COMMON ACTION
• AMEND FLOW LICENSE TO ALLOW INCREASED DIVERSION FLOWS
• CLARIFICATION OF N.F.A.
SELECT PREFERRED OPTION
• ENGINEERING
• LEGAL
• ENVIRONMENTAL/SOCIO-ECONOMIC
• REVIEW PROCESS
DECISION TO DEVELOP THE BURNTWOOD RIVER
DETAILED STUDIES: PREFERRED OPTION
• ENGINEERING DESIGN
• ENVIRONMENTAL/SOCIO-ECONOMIC STUDIES (EIS)
• REGULATORY APPROVALS
CONSTRUCTION: PREFERRED OPTION
IN SERVICE
1 YEAR
1/2 YEAR
1-1/2 YEARS
7 YEARS
TIME 0

BURNTWOOD RIVER: ACTION PLAN

FIGURE - 5

tions early in the planning process of hydro-electric developments in the north and significantly achieved government recognition of the validity of the study analyses. Moreover, considerable credit has been given to Manitoba Hydro for the study process itself by participants in the study (government and interest groups). Nonetheless, the study encountered serious setbacks during the course of its conduct and did not fully achieve its original objective of defining one preferred river development plan for the purpose of securing government approval. The study was intended to take eighteen months and to have meaningful dialogue with special interest groups, especially the Northern Flood Committee as representatives of the area Indian Bands. The study in fact, took three and a half years to complete, although the original budget was not exceeded. The study did not derive a single river development plan, and it did not achieve significant ongoing dialogue with the Northern Flood Committee. The following observations on the products of the study, the conduct of the study, and the study process itself may be helpful in future similar endeavors.

Study Contributions

Considering that the study was the first of its kind in northern Manitoba, the study made a substantial contribution to Manitoba Hydro and the participants in the study process (government agencies and interest groups) by:

- defining a preferred option on two of the three reaches of the Burntwood River and identifying the three alternatives for the best site in the third reach (this reduced the number of options requiring further planning by Manitoba Hydro in the short term and priorized the planning effort);
- identifying the key issues involved in defining the preferred river development plan;
- identifying the key activities required to address uncertainties remaining prior to selection of the first site;
- developing an action plan, with an appropriate time frame to address the outstanding activities required to meet the projected in-service date of the first site on the Burntwood River;
- developing a significant data base for ongoing environmental and socio-economic analyses. This was documented in the form of a report and six technical appendices;
- achieving an understanding by government agencies, Manitoba Hydro and private interest groups and local government in the study area of the key issues involved in decision-making on the Burntwood River System;
- assistance in the ongoing priorizing of planning activities in the Burntwood River System within Manitoba Hydro;
- bringing attention to the Northern Flood Agreement as a major factor in planning future hydro-electric development on the Burntwood River;
- identifying weaknesses within the Manitoba Government regulatory process in terms of dealing with an environmental/socio-economic study in the planning process rather than at the specific proposal stage.

From the broader public interest perspective (including local residents), the study established that there was substantial support for hydro development on the Burntwood River and for this development to occur as soon as possible (with due consideration for Manitoba Hydro requirements and alternative power generation strategies and with certain qualifications to maximize local benefits). This viewpoint was contradictory to earlier, fairly-widely held opinions that development on the Burntwood River, due to the presence of communities in the area, would be unacceptable. The study thus helped to identify areas of commonality of development objectives between the local area, the province and Manitoba hydro.

Study Difficulties

The following discussion highlights observations on the difficulties encountered during the conduct of the study.

Study Objectives and Terms of Reference. The Burntwood River Environmental Overview Study did not fit into the traditional sequence of preliminary engineering, detailed engineering and environmental studies leading up to project commitment and construction. While requiring basic engineering, hydraulic and cost data as study inputs, the environmental overview study was not intended to advance the engineering planning but rather advance the planning in a regulatory and political sense. The intent was to secure an agreement from a wide range of potentially-affected interest groups, particularly the government, with respect to an overall development plan for the river. Hence, the need to examine and analyze a wide range of impacts, both desirable and undesirable, and to develop a consensus among interest groups regarding relative importance of these impacts. Having secured agreement with respect to a general development plan, Manitoba Hydro could then proceed to plan individual generating stations according to the traditional processes which include detailed design, environmental and socio-economic review.

While the study Terms of Reference and the study objectives were reviewed extensively by Manitoba Hydro and regulatory agencies, it appears that misunderstandings were pervasive in both areas. It appear that the planning engineers within Manitoba Hydro felt the study would define project engineering modifications that would make the project acceptable before environmental scrutiny. This perspective saw the study as seeing only internal Hydro needs, rather than seeking to discern and evaluate the broader public interest requirements of concern to the Province and the affected public interest groups. Specifically, the socio-economic aspect of the broader public interest planning process was not fully understood. Manitoba Hydro engineering groups, for example, did not anticipate the extent of detailed information that was required by the study team to meet the questions of outside groups with regard to the project options; this led to some misunderstandings about the purposes of the information. This was especially true of energy economic evaluations for the various options and the extent of public interest in establishing the relative economic value of these various options, i.e., at times, groups within Manitoba Hydro felt that provision of such information to outside groups went beyond the study scope, and might prejudice future flexibility of the Corporation to adjust its plans, programs and projections. As a result, there was considerable debate within Manitoba Hydro as to the validity of the study objectives. This debate was not fully resolved during the course of the study. The internal climate within Manitoba Hydro, therefore, was not fully supportive of this study; this contributed to delays in the study. Meanwhile, the Manitoba Government regulatory process was dealing with such a study for the first time and therefore was also learning how to deal with these very same issues. The implications of meeting the Terms of Reference and study objectives were not well understood at the outset.

"Environmental Overview" versus Environmental Impact Statement. This study attempted to integrate engineering, economic, environmental and socio-economic considerations early in the planning stages, that is, before there was a commitment to build any project. In fact, Manitoba Hydro indicated at the outset of this study that the earliest possible in-service date for an option on the Burntwood River was in the early 1990s. Therefore, there was no immediacy of construction of any of the project options. This presented an entirely different problem for the regulatory process which is accustomed to dealing with a specific project proposal. This was especially novel for the external groups participating in the liaison process.

The fact that groups participating in the study were asked to review a wide spectrum of options with no imminent construction of any option required a new and different perspective which was reflected in many ways. One of the concerns related to the adequacy of environmental and resource data. Most of the parties were accustomed to seeing some form of checklist of biophysical impacts, as is traditional for specific proposals. The study team recognized that base data in northern Manitoba are somewhat sparse in many areas, including the Burntwood River System. It was also emphasized to the liaison groups that the data need not be as complete as would be expected for a detailed EIS. Rather, the study team constantly had to remind its own members as well as the external groups, that the data must be commensurate with the decisions that were being made, that is, the screening of options and the ranking of options. Detailed studies would follow before project commitment. The phased approach to the study assisted in providing check points for the regulatory agencies to satisfy themselves that data presented did in fact support the conclusions that were drawn to that point in the study. The earliness, in terms of project development of the environmental and socio-economic studies, also raised questions about the adequacy of the project descriptions of the various project options; for example, some options had been studied in considerable engineering detail while other options had considerably less detail. As a result, hydraulic profiles and flooded areas and the energy outputs were less clearly defined for some options than others. In the same regard, it was difficult to get work force estimates and other socio-economic breakdowns on certain projects when these kinds of details had not been addressed in the engineering studies. The study team was gratified to find, at the conclusion of the study, that the Technical Advisory Committee and the Working Committee of Manitoba Hydro agreed that data had been adequate to support the study conclusions.

Screening of Project Options. The integration of engineering, environmental and socio-economic considerations early in the planning process can be of material assistance to the planning process within the power utility. Some options were deleted during the course of this study. While these options, for the most part, were less attractive to Manitoba Hydro than the ones that were retained for further study, nonetheless, Manitoba Hydro could not be confident of reducing its planning effort on these options until it had government recognition, including some external discussion, that these options were not highly attractive for other reasons. Because detail used for planning studies is less than for site-specific studies, there was some concern about the level of information used in the study. Considerable effort was spent on educating the participants in the liaison process on the adequacy of the information supporting the deletion of options. When participants specifically reviewed whether additional information would change relative rankings, the concern diminished and consensus was usually obtained. The phased approach to the progressive deletion of options assisted in demonstrating that the information justified the conclusions.

External Liaison. The Terms of Reference for the study specifically required dialogue with the government regulatory groups and specific interest groups in the study area. Manitoba Hydro was given much credit, from the outset of the study, for adopting such an open approach to its planning process. Without exception, the groups that participated in the liaison process commended Hydro on the study process. The study encountered a significant drawback to the external liaison process when the Northern Flood Committee decided not to participate on an ongoing basis in the study because it might prejudice their entitlements under certain aspects of the Northern Flood Agreement. While the study team was able to have dialogue with certain native communities, and the NFC received all study documents, nonetheless, that lack of dialogue with the NFC was a major shortcoming in the opinion of all the participants of the study. In spite of this shortcoming, significant gains were made in terms of dialogue with other local communities, such as the City of Thompson, communities of Split Lake, York Landing, and non-status community of Nelson House, the Local Government District of Mystery Lake and Inco. Those groups that participated gained much greater understanding of the issues involved with respect to potential river development on the Burntwood.

Manitoba Hydro gained support and understanding for the planning decision. The external liaison process did require substantial commitment, time and effort. Within Manitoba Hydro, there was not unanimous support for sharing the planning information with special interest groups, some of which could be opponents in future resolution of issues. This led to protracted discussions within Manitoba Hydro and contributed to study delays. With respect to the government regulatory agencies, these groups were not sure to what extent they should assist in enhancing the dialogue with interest groups. The government was hesitant about compromising its independence by attending liaison meetings with interest groups. While the liaison process absorbed a substantial amount of the study effort, the study team believes that these efforts were extremely valuable and should be an integral part of any future, similar environmental and socio-economic studies in the north. Commitment by all parties to information-sharing is essential to success of dialogue. It should be noted, however, that liaison activities are very time-consuming. Originally the study was to have been completed in eighteen months. The reasons for the delay were not directly related to liaison activities, however, it is now realized that the planned liaison activities could not have been accomplished as originally envisaged in the span of an eighteen-month study.

Study Approach. The study approach was unusual in a number of ways. The study explicitly identified an issue-focused approach to the screening of options on the Burntwood River system. Rather than compile a detailed checklist of potential impacts, the study, at the outset, identified key issues as they might be perceived by interest groups with respect to Burntwood development. These issues were discussed with interest groups, including government and Manitoba Hydro, and these then formed the focus of subsequent study. The study then focused on impacts, as identified by people, that is the users of resource, instead of directly on elements of the biophysical environment. The study did not ignore the biophysical environment itself, rather, the significance of the biophysical concerns was related to their implications with respect to the key issues identified by the resource user, and regulatory agencies. The issue-oriented approach seemed to work well, although it seemed to take at least three meetings with interest groups before the real issues surfaced from these various groups. It is extremely important to have the continuity of dialogue such that the real issues can be identified. Terminology with respect to the issues must be straightforward and simple. Initially, some of the issues that were identified by the study team were too obscure to be relevant to the interest groups. As dialogue became effective with the interest groups, they participated in the sharpening of the focus of the specific issues.

The study explicitly analyzed the key issues according to both monetary and non-monetary impacts. Monetary impacts provided the net quantifiable effects in dollar terms. The non-monetary effects were assessed more subjectively by the study team and the use of the inputs of the participating interest groups. The monetary analyses also led to some problems. While it was not forecasted at the start of the study, analysis revealed that power values of the various sites in strict monetary terms dominated the resource and socio-economic monetary assessments. This was illustrated in Table 2. Forestry and fishing resources, on this basis, were less than one million dollars (present value), while the power values were over thirty million dollars. While few disputed the validity of the monetary assessment, nonetheless, the relative magnitude of these elevations concerned people. The study team found it necessary to remind participants constantly that the power values were used to consider one project option relative to another in monetary terms. Power was valued on the basis of "if and when" generation was required on the Burntwood River, i.e., the power values were not to be used in absolute terms to assess if any specific option was economically feasible. In addition, the study team continously emphasized that the monetary evaluation was a starting point from which people could then introduce their value judgments, such that the trade-offs between monetary and non-monetary evaluations could be made on the basis of all the available viewpoints.

A more conventional study approach might involve greater separation of power valuation, environmental analysis, and local socio-economic impact analysis than was adopted in this study. Greater separation of these subjects, however, can encourage the adoption of rigid positions by different major interest groups, e.g., the utility may select options based solely on power valuation (without appreciation of non-monetary values) while affected interest groups may reject options based solely on local environmental impacts (without consideration of monetary values). Focusing on the overall package of impacts also helped local native interests to consider a balanced assessment of job, development and potential negotiated opportunities versus the more readily apparent environmental changes. The study approach was therefore especially valued in that it focused attention on the monetary and non-monetary trade-offs that each interest group should share in evaluating. The study team believes that although this approach undoubtedly created delays and problems during the work program, it was a critical factor leading to general acceptance of the final study conclusions.

Finally, the study approach was somewhat unique in the high degree of co-ordination between socio-economic and environmental components. Because the study approach was unusual, the study suffered from a series of delays which were beyond the control of the study team. These delays seriously affected the understanding of the approach, primarily through disruption of the continuity of liaison with the interest groups. As a result, the study team continuously found it necessary to re-educate the various audiences on the approach to avoid misunderstandings.

Inter-disciplinary Approach. The integration of environmental considerations and socio-economic considerations into one study team was extremely beneficial to the study. At the outset, the project descriptions of the various options were developed with the needs of both environmental and socio-economic studies in mind. The discussions with the regulatory agencies and the special interest groups were all conducted on the same basis. This led to an effective integration of biophysical and socio-economic evaluations with respect to the resource components such as fishing, forestry, trapping, recreation, etc. The regulatory agencies and the interest groups did not differentiate between environmental and socio-economic questions. On this basis, the co-ordination that was required of the consultants assisted in addressing the concerns from these participants in the liaison process. Had the consultants not had the mandate for this inter-disciplinary approach, there would have been an onus on Manitoba Hydro to provide this co-ordination. The co-ordination would have been extremely difficult to provide from outside the study team. The discussions with the interest groups were interesting with regard to the issues raised. Rarely did an interest group raise simply environmental concerns or simply economic concerns. Instead, the discussions usually began with concerns about jobs and business effects (i.e., the potential positive effects), and then turned to some of the potential negative aspects, such as flooding and flooding-related issues. An inter-disciplinary approach assisted the study team throughout the study.

Commitment to a Study. It may be self-evident that a strong commitment to the study is required when undertaking one that has some unique characteristics. Once a liaison process external to an organization has been initiated involving, in this case, extensive dialogue with government departments and interest groups in the study area, it is important that the liaison be carried through to a meaningful conclusion. If not, the credibility of all participants is reduced. For the Burntwood River Overview Study, there were many times when the study could easily have been ended prematurely. The strong commitment to the study process and to the value of achieving recognition of the study conclusions from the Hydro project management assisted greatly in carrying the study to the end and achieving the ultimate endorsement of study conclusions.

THE RG&H SITING PROCESS -- A NEW APPROACH

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The purpose of this paper is to first describe the RG&H Siting Process, originally developed for application to siting of Canadian Arctic hydrocarbon facilities, and then to compare it to two other approaches, Delphi or Nominal Group processes and decision analysis. As far as the authors know, this paper is the first comparative analysis of these methodologies. It is based on the siting experiences of the authors and others at Rogers, Golden & Halpern. The principal conclusion is that while each method has advantages and drawbacks, the RG&H method is unique in its advocacy approach and in its adaptability to the complexity of siting problems.

INTRODUCTION

In March 1982, Rogers, Golden & Halpern submitted to Environment Canada and Indian and Northern Affairs Canada its final report, A Process for Siting Hydrocarbon Facilities on the Canadian Arctic Coast. This report introduced a new approach to siting created in response to special problems with managing land use activities north of 60 degrees. Under the terms of reference of the study, the method was to be based on Canadian and U.S. state-of-the-art siting methodologies. Although the process was directed at a specific geographic area and group of facilities, it has a broader applicability that suits other siting situations.

Later, a workshop was held in Ottawa to evaluate the feasibility of implementing the RG&H Siting Process north of 60. At the workshop, which was attended by 32 representatives of government agencies, consultants, and public interest groups, the method was presented and then tested using an Arctic Coast scenario. Three siting teams were chosen from among the participants; each consisted of a facilitator, a public group, an industry group, and an environmental group. This workshop simulated the process, albeit on a greatly reduced scale and a highly compressed schedule of one afternoon.

The reactions of the participants to the RG&H Siting Process were compiled and presented with a discussion of regulatory issues and options involved in implementing a siting process. (See Implementation of a Facilities Siting Process for Development Projects in Northern Canada, March 31, 1983, by H. Mills.) This report recommended (1) developing and implementing a siting process for major development, and (2) testing a modified RG&H Process on an actual siting problem in the North as soon as possible.

Meanwhile, the RG&H Siting Process evolved through application, and elements of it developed. The current focus is on balancing the recommended advocacy approach with the manageability of the process.

This paper centers on the methodology of the process rather than its implementation (which is currently proceeding in Canada). Specifically, the following key elements and characteristics of the process will first be described and then contrasted to other approaches:

- the degree of quantitative and qualitative analysis,

- the balance between objectivity and subjectivity,
- the advocacy approach to siting,
- the reasonableness of participant responses,
- the role of the facilitator, the participants, and the decision-makers,
- the personal and group dynamics of the process,
- the defensibility of the logic of the approach, and
- the support components of the process, including information management and technical expertise.

Although many methodologies are available for the purposes of this comparison, each with some record of application to siting, two very different classes of approach are well-suited to the endeavor. The first -- Delphi or Nominal Group processes using numerical weighting -- is the most common. The second employs decision analysis techniques and is the most quantitative and mathematically rigorous. The MG&H Siting Process shares elements of both but at the same time does not belong in either class. Because it discusses three methodologies, the comparison both makes use of current siting theory and identifies directions for improving the practice of site selection.

The reader is asked to keep in mind that this paper only discusses methodologies for siting contiguous facilities, even though these methodologies are applicable to linear route selection.

OVERVIEW OF SITING

Site selection has occurred since prehistory, although without the fuss, data collection, documentation, and consternation that have become synonymous with siting, particularly when it is referred to as a "selection process" or "methodology". The basic site selection ground rules are still the same: given the need to locate or site a facility, those with the responsibility for the choice consider their own interests, analyze the available options, and select accordingly. This occurs either holistically by using an intuitive integration of the known facts, or systematically by looking at the data individually, by establishing standards or criteria to compare alternatives, and by following a series of logical steps to reach a decision.

Today, siting decisions are made one of two ways, either by the "seat-of-the pants" (or product-oriented approach), or the process-oriented approach. In the former approach, first the site is found (by methods such as widespread reconnaissance with teams of experts or examination of existing landholdings), and then justified on its own merits (i.e., acceptable impacts). Using the latter approach, the region of possible options is examined comprehensively from available data and then narrowed from regional scope to smaller areas, eventually arriving at a preferred option. The selection is justified in comparison to available alternatives.

Neither approach lacks pitfalls. In the product-oriented (site-oriented) selection approach it is not possible to demonstrate (or presumably even to know) if a more suitable site exists either from an environmental or economic point of view. Identification of alternative sites is particularly important in the U.S. owing to the National Environmental Policy Act (NEPA) requirement in environmental assessment to consider alternatives to a proposed action. In Canada, meanwhile, the Environmental Assessment and Review Process (EARP) focuses on the acceptability of the impacts of a proposed action not on comparisons of alternative sites. Unfortunately, should the process find against a project, then the availability (if any) of an alternative becomes essential to the future of the project.

A process-oriented approach may be both lengthy and costly yet fail to reach a consensus on a preferred and approvable site. Or the method may even become an issue itself that must be resolved before facing the harder decision on a site. From the perspective of the proponent of a facility, some incentives might be anticipation of achieving smoother permit approvals or improving prospects for overcoming public opposition.

Although the basic objective of siting -- to find a site -- has never changed substantially, modern siting problems have a new dimension, namely the number of second and third parties who participate in some way in the siting decision. Because they have something at stake, second parties have always found a voice in the decision, whether as owner of the site, financier of the project, or as some other participant. As representatives of some public good or group indirectly affected by the decision, third parties have gradually increased their influence. National interest legislation, particularly in the area of environmental protection, is the primary impetus for recent changes in the status of second and third parties in siting decisions. Accompanying the increase in the number of participants in the siting process, new techniques in siting have evolved and the concepts of mediation used in other types of disputes have found a place in the selection of sites.

The basic premise of siting is that significant differences exist in the suitability of various potential sites either in the cost to develop them or in their environmental or sociopolitical impacts. This premise is not always examined at the beginning of a siting study. Unfortunately in some cases this leads to wasted effort. That is, the effort is directed at finding the site for a facility when it has not even been established yet that the project should go ahead at all. Clearly only a fine line exists between siting directed solely at finding a site and certain aspects of environmental assessment and regional land use planning.

OVERVIEW OF SITING METHODS

There are many different siting approaches and methodologies. Not all are mathematically valid, many are hard to comprehend, and none guarantee that all parties will accept the results of the process. Consideration of the appropriateness of siting methods for particular applications is the primary emphasis of this paper.

When an approach or methodology other than direct selection and defense of a site is used, a series of steps or a sequence of activities is usually carried out to select a site. The process may be explicitly defined, almost in a cookbook fashion, or it may be described by a series of general guidelines, where application to a specific siting problem is left to the creativity of the participants. Some methods are less formally documented, but nonetheless it is possible to construct a series of instructions for them. In this paper a siting method or methodology is defined as: a systematic progression of steps or activities that can be written or described, that are used to select a site, and that can be used to understand and repeat the process, although not necessarily with the same result.

Siting methods, though they vary greatly, have many common objectives and some common steps. Most common is the progression through intermediate levels from a large region to a preferred site, which are typically called candidate areas and candidate sites. (See Environmental Criteria for the Siting of

Thermal Power Plants by J. Halpern.) This phased or hierarchical approach is typically followed because both the data and funding that are available for a siting study are usually limited. If the region from which sites are to be selected contains a large number of possible sites, it is often not possible to examine each of them with the finest level of detail. Instead the number of possible sites is narrowed by applying in stages increasingly detailed site-specific data to progressively fewer areas. At the macro scale many siting methodologies, including the three under consideration, have the following general steps:

1. Define the siting problem;
2. Select candidate areas;
3. Select candidate sites from candidate areas; and
4. Select preferred site(s).

It is the means used to accomplish each of these steps that distinguishes one approach from another. An explication of these differences appears below.

Differences between Siting Methodologies

Some of the principal differences between siting methodologies are

- the extent to which they rely on exclusion criteria;
- the techniques they use to consider trade-offs;
- the way in which input of the participants are elicited and included;
- the procedure they use to reach consensus when more than one participant is involved;
- the way they incorporate uncertainty about effects and attitudes toward risk; and
- the way they evaluate effects that vary over time.

With exclusion criteria, all potential sites that do not meet a certain minimum level of performance in a criterion are eliminated. Although the use of exclusion criteria is a simple concept, it is not always the best one. An exclusion approach should only be used when a certain level in one criterion makes a site unsuitable regardless of the site's level of performance in other criteria. In an exclusion approach, outstanding performances in other criteria cannot offset poor performance in an exclusion criterion. The critical factor for exclusion criteria is the thresholds that are set for making an exclusion determination. Thus, possible shortcomings of an exclusion approach are that it may eliminate all realistic sites or not be selective enough to sufficiently reduce the area under consideration. Almost all site selection methods use some exclusion criteria but they differ in the number of such criteria and the permissible justifications for their use.

The concept of a trade-off -- a choice among situations all of which are not attainable at the same time -- is crucial to a siting methodology that does not rely on exclusion criteria. It is possible for trade-offs to be either direct or indirect. A direct trade-off would simply chose among options, although they may be complex. An indirect trade-off might use some type of index, such as a weighted suitability score, to compare sites. For instance, weights and scores are used to try to predict preferences for certain situations. The concept of trade-offs is discussed further with regard to the three-methodology comparison below.

Other major differences between siting methods are the types of questions asked and the types of response needed. For example, clear questions that ask for a preference between two alternatives are easier for participants than those with less direct questions.

Many current siting methods involve several participants with dissimilar points of view. Methods with numerical weights use successive rounds of questions, comparison of weights to group averages, and interchange of participants' rationale for weights. When the process has gone as far as it can toward consensus, average weights are used. Unfortunately, averaging of weights is not equivalent to averaging of viewpoints -- the results may not represent a reasonable compromise or point of view of any one participant. An alternate approach is to use the weighting results of each participant independently and try to achieve agreement on sites that have been selected by several participants for different reasons.

The last two items of differences between siting methods -- incorporation of risk and consideration of effects that vary over time -- are not addressed explicitly by the bulk of siting methods. Attitudes toward risk are implicitly considered in evaluating the suitability of various situations for a facility, if the evaluator is aware that it should be considered. In fact, preferences in siting reflect some attitude toward uncertainty, otherwise sites prone to mitigable effects would not be avoided. Time-dependent effects are usually considered by preferences for sites subject to short-term effects over those subject to long-term effects.

Rigorous analysis of attitudes toward risk and variation with time are provided only in decision analysis methods, which are discussed below as a specific siting process.

DESCRIPTION OF THE SITING METHODOLOGIES COMPARED

In order to highlight the differences between the RG&H Process and other approaches that have been applied to site selection, two representative methodologies were selected for comparison. A description of these methods follows that of the RG&H Process. Using the five major steps of the RG&H Process as a framework, the comparable activities for each of the three methodologies are listed in table 1. The table is a highly condensed description of each process and should not be considered a complete accounting of the text. The nomenclature section is meant to aid the reader with the distinct vocabularies of each methodology.

The RG&H Siting Process

The following description is based largely on the workshop proceedings cited earlier. The authors felt that an independent summary by someone other than the developers of the process might provide some useful insights into how it operates and is perceived by others.

The RG&H Process has its philosophical basis in an advocacy approach to consensus building. It brings participants with vested interests in a siting problem together at an early planning stage, and involves them in a structured process that focuses on the development of mutually agreeable solutions at each stage of the process. By starting with a large region and regional considerations and gradually narrowing towards selected sites, the process eliminates clearly unacceptable areas and sites.

Choices inevitably become increasingly difficult as the participants advance through the process. The RG&H Siting Process avoids the use of

TABLE 1. COMPARISON OF ACTIVITIES BY MAJOR STEP IN THE THREE METHODOLOGIES

	METHODOLOGY		
MAJOR STEP	RG&H SITING PROCESS	DELPHI/NOMINAL GROUP PROCESSES USING WEIGHTED SUMMATION	DECISION ANALYSIS
1. Define the siting problem	- Develop facility profiles/options - Identify potential effects - Identify participants (interests) - Establish region of interest	Similar to RG&H Process	Similar to RG&H Process
2. Translate regional screening issues to spatial preferences	- Identify objectives and criteria for each participant - Investigate data available for each criterion - Consider exclusion/inclusion criteria - Identify and map best n % of the siting region for each participant	- Identify issues and criteria - Consider exclusion/inclusion criteria - Investigate data available for each criterion - Determine data categories and ratings within each criterion - Determine weights for issues/criteria for each participant - Compute group average weights and standard deviations - Calculate suitability scores using consensus or average weights - Map ranges of scores for region	This step is conducted in various ways, such as exclusion screening outside of decision analysis process
3. Select candidate areas	- Select areas from best n % for all participants to represent each point of view	- Determine cutoff score for selecting candidate areas - Map areas	This step is conducted in various ways outside of decision analysis process
4. Select candidate sites from candidate areas	- Define additional criteria - Verify regional data - Collect additional data - Select candidate sites to represent each point of view	- Define additional criteria - Verify regional data - Collect additional data - Select candidate sites by consensus or professional judgement	This step is conducted in various ways outside of decision analysis process
5. Select preferred site(s)	- Develop site-specific criteria - Collect new data and perform more detailed studies - Use participants' preferences or decision analysis (for quantifiable risks at issue) to select preferred/alternate site for each participant - Examine selections for consensus - Use negotiation and mediation to select recommended site	- Develop site-specific criteria - Collect new data and perform more detailed studies - Determine ratings and weights for each criterion (as for candidate areas) - Compute site/option suitability scores - Use scores to rank sites - Sensitivity analysis (optional)	- Specify objectives and attributes to compare candidate sites - Describe possible impacts for each candidate site - Determine risk (probability) of possible impacts at each site - Verify necessary assumptions - Assess preferences for possible outcomes and construct single-attribute utility functions - Assess preferences for trade-offs and calculate scaling constants - Calculate expected utility at each site - Sensitivity analysis (optional)

numeric weighting as a decision-making technique in favor of more subjective approaches for assessing preferences and making trade-offs.

The process is based on democratic principles. It assumes that all important interest groups are represented by the participants, including the public, public interest groups, industry, and government. As some elements of the process are highly technical, it may be desirable to have **technical experts** to assist the siting team and ensure that the necessary information and expertise are available to address the siting problem. The process also assumes that the siting effort will be led by a **facilitator** to organize and direct the exercise and to implement procedures for conflict resolution.

The RG&H Siting Process, as described in the report and graphically portrayed in the process flowchart accompanying it, has the appearance of complexity. In actuality, the basic concepts of the siting process are simple, and the effort required to implement them depends on the specific siting problem and the procedures employed by the facilitator and the participants. The following is a simplified summary of the five major steps in the process.

Step 1: Define the Siting Problem. This step establishes the framework for any siting exercise. The siting problem must be recognized and understood, and procedures for addressing it must be established. This includes development of a facility profile, comparison of facility/site options, identification of potential effects, establishment of a study area, and consideration of who should participate in the process and in what role.

Step 2: Translate Regional Screening Issues to Spatial Preferences. Each participant specifies objectives for regional screening purposes and related criteria that can be mapped to express spatial preferences. (Data availability must be considered when selecting criteria.) Inclusion/exclusion screening may be used subject to certain predefined rules. In accordance with agreed constraints and guidelines, each participant then proceeds to select the best **n** percent of the study area from a personal viewpoint by applying criteria, combining exclusion/inclusion areas, and making low-order trade-offs. Step 2 is the most complex step in the process.

Step 3: Select Candidate Areas. From those portions of the study area determined by regional screening, candidate areas are selected in accordance with the preestablished rules of the process. At this level in the process at least one area must be **acceptable** to each of the participants, but it need not be their preferred area. The rules are designed to keep all participants involved in the process and to select areas of interest to most of them.

Step 4: Select Candidate Sites from Candidate Areas. This step involves a re-examination of the objectives and criteria developed in Step 2, and the definition of more specific criteria and reconnaissance data requirements. The siting team then verifies the regional level data and revises the selection of candidate areas, where appropriate. Using professional judgement, an agreed number of candidate sites is selected, with at least one potential site acceptable to each participant.

Step 5: Select Preferred Site(s). This step includes: the development of site-specific criteria, preferably based on refinements from previously established criteria; the collection of new data on each of the sites; and the evaluation of potential effects at each site using more detailed studies. A "decision analysis procedure" may be required to deal with risks that are quantifiable. Each participant or interest group then ranks the candidate sites, and determines which sites are acceptable or unacceptable. Where there are no sites, or an insufficient number of them that are acceptable to all participants, negotiation procedures are employed. The final product is the selection of a preferred site(s), hopefully by consensus, but also by arbitration where necessary.

Two somewhat unique aspects of the process are its reliance on advocacy and the degree of democracy involved in having the public and public interest groups directly involved as participants on the siting team. The RG&H Process also allows technical input to be separated from policy input, enabling the process to decide where a facility should be built, not if it should be built. The siting effort brings potential adversaries into working contact with one another on regional screening/technical matters. The siting process therefore encourages the development of mutually agreeable solutions to the siting problem, and reduces the potential for conflict. Despite the involvement of the public, industry, and government in the proposed process, the final product will always be subject to political decision-making. Therefore, it is important to define the final product of the RG&H Process in such a way that it facilitates inevitable political decisions.

Delphi/Nominal Group Processes Using Weighted Summation

Anyone who has had even mininimal involvement with systematic site selection is usually familiar with both the widespread Delphi or Nominal Group processes and the concept of numeric weighting. In spite of the fact that such methods are commonly used, there is some confusion as to what actually constitutes a Delphi or Nominal Group process.

Originally the term "Delphi" referred to a very specific technique, the principal characteristics of which are that it is (1) used to predict some future event or value by (2) questioning experts in a specific field who (3) have no contact with one another or even know the identity or predictions of other experts. The name of the process comes from the ancient Greek Oracle at Delphi, hence its connection with a process used for forecasting. A typical Delphi process would include several rounds of the experts first generating predictions and then summarizing the group's opinions and allowing predictions to be changed in light of the response of the group.

A Nominal Group process, on the other hand, brings together representative individuals in a structured forum to identify concerns and, in many cases, to establish preferences or priorities. Members of the group actually nominate issues to be considered for a comprehensive list that is compiled and reviewed. In some applications, the process actually stops with issue identification, but in the typical siting application, the issues or specific criteria that reflect the issues are ranked or weighted as well. The process maintains anonymity of the participants for their (written) rankings or weights but not for opinions they express during discussions of the relative importance of issues.

In a typical Nominal Group process there are many participants representing a variety of interests. However, this process can also be conducted internally by the proponent of a facility to determine technical preferences of the persons involved in its licensing, construction, and operation. Usually several rounds of issue identification and weighting are conducted to attempt to achieve consensus. The results of rounds are often compiled, and statistics on the preferences of the group are used as a focus for discussion in the succeeding round. The facilitator or moderator has the responsibility of not only organizing the process and promoting consensus, but also must decide when the results of the process have stabilized. Once rankings of issues or weights between issues do not change significantly from round to round, the group has reached consensus. But if consensus is not reached, for example if the group is polarized into two factions, the remainder of the siting process may be carried on with two sets of rankings or weights.

Delphi or Nominal Group processes are not necessarily bound to the use of weighting, although they do most often. Therefore, the methodology considered in this paper is specified as Delphi or Nominal Group Processes Using Weighted Summation. In referring to this type of process no formal division is made between a Delphi process and a Nominal Group process because under the prevalent usage of these terms, they are not distinct and are not separated according to the historic classification described above.

Weighted summation is a specific technique or model for calculating a suitability index that is used to rank alternatives, in this case sites. For the weighted summation model (figure 1) useful distinctions are first made within each issue or criterion. Say, for example, wildlife productivity is the criterion. Three distinctions may be made, such as low, medium, or high productivity. Each level of distinction or category that is made within a criterion is assigned a value or rating (**v**), typically on a fixed but arbitrary scale (0-1, 1-10, etc.) common to all criteria being considered. A graph or table showing the values for all levels within the criterion is called its value function (figure 1, Step 1). The end points of the scale can be based either on the range of conditions that are known to occur in the region of interest or on a broader "absolute" range of possible conditions. A weight (**w**) is subjectively assigned to each criterion to represent a person's judgement of its relative importance with regard to other criteria (figure 1, Step 2). For instance, a maximum weight of five could be used to indicate "extremely important", and other criteria would be assigned weights with respect to this maximum. Suitability of a site or area is then calculated as the sum of the products of the weights and ratings for all criteria (Σ **w** x **v**).

The weighted summation model is mathematical and the weights and ratings must therefore have certain mathematical properties in order to accurately reflect preferences. Describing alternatives as low, medium, or high (using 1=low, 2=medium, and 3=high so that the numbers only represent a ranking) is an **ordinal scale** and is not a valid value function. To be meaningful, a value function must be based on an **interval scale;** that is, the progression from 1 to 2 is as important as from 2 to 3. In this example, if medium were valued as closer to low than high, it might be rated 1.5.

The weighted summation model seems conceptually uncomplicated, although this is not necessarily so if verification of all the assumptions is required. Indeed, misapplications of weighting are common, including those in which a participant sets the weight for a criterion (1) without understanding the meaning of weights, or (2) without knowing its value function or range of variation, or (3) with its value function preset by others.

The first case is obviously a problem. Without understanding the weighting process it is unlikely that weights will accurately express preferences.

Step 1. Assign values (v) to criteria levels.

Value Function for Criterion 1

level	v
A	1
B	2
C	3

Value Function for Criterion 2

level	v
M	1
N	2
O	3

Step 2. Assign importance weights (w) to criteria.

Criterion 1 w = 4

Criterion 2 w = 5

Step 3. Multiply values by importance weights and combine.

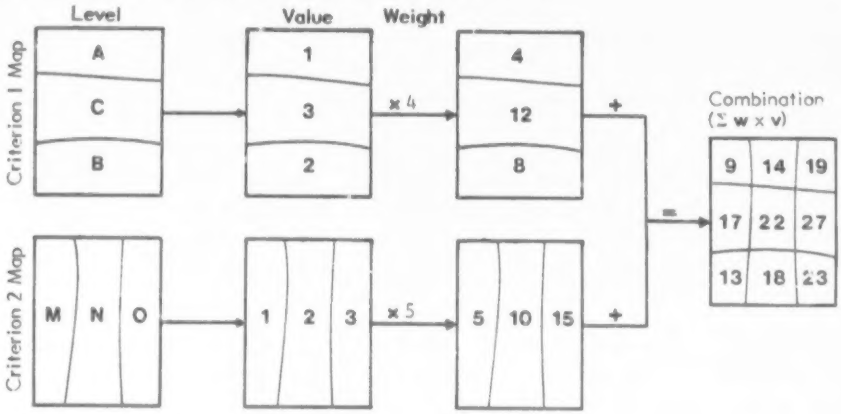

FIGURE 1. - THE WEIGHTED SUMMATION TECHNIQUE

The second case is equivalent to assuming that valid weights can be set abstractly without knowing the units to which the weights are to be applied. Use of weights for evaluating the relative importance of generic objectives is meaningless. Only when the weights can be related to a tangible but not necessarily economic trade-off can they be interpreted to indicate preferences.

The third case has a more subtle, less serious flaw. Both weights and ratings are usually subjective. If the same person does not assign both, they will not necessarily represent a personal point of view. There are some cases (e.g., presence/absence and cost) in which the value function is deterministic and can be specified objectively by expert judgement.

Weighted summation can be used to select candidate areas or sites. In selecting candidate areas from a large study area, a computer-assisted geographic information system is often used to overlay mapped information and produce a graphic representation of the implications of weights. Otherwise, the process would be painful to implement in the regional screening phase (Step 2). Table 1 describes the activities for a Delphi process with weighted summation used in both Steps 2 and 5. Other approaches to selecting candidate areas and sites have been used with a Delphi process. In some applications of weighted summation (and other siting techniques) a sensitivity analysis is conducted to determine the effect on the results of varying assumptions and preferences. This might be accomplished by testing a wide variety of weighting schemes and comparing their effect on the ranking of sites.

To understand this methodology it is important to separate the features of the group dynamics (Delphi or Nominal Group) portion of the process from the mathematical (weighted summation) portion. The former supplies the format and rules for interaction and consensus among participants, while the latter interprets these interactions in a predefined way that may not be appropriate to every siting problem.

Decision Analysis

The following discussion of decision analysis as applied to siting is necessarily simplified. Specifically, the assumptions it makes and their verification are not described. The reader is referred to the literature concerning decision analysis methodology.

The decision analysis siting procedure is based on the assumption that the attractiveness to a participant of an alternative (i.e., a site) in the siting process should depend on (1) the likelihood of the possible outcomes (consequences) at each candidate site, and (2) the participant's preferences for the possible outcomes. The probabilities of various consequences are established by professional judgement of technical experts. Preferences are established by structured questioning of the participant. Utility theory (from economics) is used to quantify these preferences.

In some ways decision analysis is similar to the weighted summation portion of the Nominal Group process. Specifically, utility functions are comparable to value functions and scaling constants (also called decision analysis weights) have a similar function to relative importance weights. However, these processes have important differences. While the weighted summation approach uses numbers, the decision analysis approach uses mathematics. No weights or ratings are accepted in decision analysis without rigorous verification that the necessary assumptions are appropriate. The participant responses are elicited by carefully constructed questions that tend to eliminate possible misapplications such as those discussed for weighted summation. Whereas a purely arbitrary weight could be supplied in weighted summation, it is very unlikely in decision analysis.

Unfortunately, this conceptual purity comes at the expense of the participant who may have to answer a large number of extremely difficult questions. In a typical decision analysis application the number of objectives and attributes is limited to minimize this situation but in order to do so objectives and attributes must sometimes be combined and used in a form not familiar to the participant. For operational reasons, then, decision analysis tends to aggregate issues rather than maintain them as separate entities.

In order to construct utility functions for each attribute -- an attribute in the decision analysis siting methodology is comparable to a criterion in the other two methods -- the primary device used in decision analysis is a lottery. A lottery is a choice between two possible outcomes each with a stated probability of occurence. For example, the participant might be asked to state a preference between: a lottery with a 50 percent chance of the best outcome and a 50 percent chance of the worst outcome for an attribute or a given outcome somewhere in between. Depending on the answers to a series of such questions the form of each single-attribute utility function is defined indicating the participant's attitude toward risk.

The lottery procedure must be performed for each attribute in order to establish the relative differences between intermediate situations within the range of conditions that occurs for each attribute. The utility functions typically define the range for each attribute on a scale from 0 to 1.

In order to establish some comparability between utility functions for different site attributes, a scaling constant must be computed for each attribute. The first step is to establish the appropriate form of the combined utility function for all attributes -- additive or multiplicative. The additive form is very similar to the weighted summation model. Scaling constants are derived by determining trade-offs involving two attributes about which the participant is indifferent. The utility function for one of the attributes must be known.

Once the single-attribute utility functions and scaling constants for all attributes and the form of the multiple-attribute utility function are known, a composite or total utility can be computed from the levels of all attributes. If a specific level for each attribute can be assigned to a candidate site, the total utility of that site can be computed and compared to that of other sites. However, because not all outcomes in decision analysis are certain, risk must be incorporated into the utility scores using the concept of expected utility. The expected utility at a site is the sum of the products of the utility of each possible outcome and the probability of its occurrence. The probability of various outcomes requires its own risk analysis methodology and is addressed in this discussion. The key element of the decision analysis methodology is not how risk is determined, but how it incorporates risk.

Table 1 limits the decision analysis procedure to Step 5 of the RG&H framework because the process up to and including selection of candidate sites does not include elements that distinguish it from other approaches. Decision analysis is so intensive and rigorous an effort that it can only reasonably be applied to comparing specific sites.

Step 5 of the RG&H Siting Process uses decision analysis where risks are an issue and can be quantified. This recognizes both that decision analysis is unique in its ability to consider risk and that the process is perhaps overly complex when risk analysis is not possible or important. The decision analysis component of the RG&H Process is intended to be a simplified version of the full process.

COMPARISON OF THE THREE METHODOLOGIES

The preceeding descriptions of the three methodologies have been mostly independent and non-critical. Establishing this background is necessary prior to an in-depth but brief comparison. All three methods have been used in siting and have advantages and disadvantages that are known to their developers and users.

The primary vehicle for the comparative analysis is table 2, which contrasts the methods according to 13 key process characteristics. The thirteenth row in the comparison matrix is used to highlight the unique elements of each methodology and is, in a sense, a summary of a summary. The

TABLE 2. COMPARISON OF CHARACTERISTICS OF THE THREE METHODOLOGIES

PROCESS CHARACTERISTIC	METHODOLOGY		
	RG&H SITING PROCESS	DELPHI/NOMINAL GROUP PROCESSES USING WEIGHTED SUMMATION	DECISION ANALYSIS
Applicability	Regional screening through selection of preferred site	Regional screening through selection of preferred site	Selection of preferred site only
Degree of quantitative and qualitative analysis	Generally qualitative with quantitative analysis within individual criteria and in characterizing candidate areas and sites	Usually more qualitative than quantitative but use of numerical scores (weights) implies more quantitative	Mathematically rigorous and highly quantitative but uses qualitative analysis to establish participants' preferences and attitudes toward risk
Balance between objectivity and subjectivity	Primarily subjective approach for each participant but overall process leads to objective decision	Subjective choice of issues and criteria but objectivity of decisions is assured by assigning weights and ratings without knowing sites	The complexity of the method assures objective decision but subjective choices are made throughout the process.
Use of advocacy and mediation	Advocacy-based approach that relies on strongly held opinions and preferences and mediation for success	Weak advocacy in selection of issues, criteria and weights; "Mediation" is via the process through averaging or combining of scores as agreed in advance	Weak advocacy in selection of preferences by participants; "Mediation" is via the process through combining of utility scores as agreed in advance.
Reasonableness of participant responses	Responses are primarily direct choices of preferences for trade-offs, attitude toward mitigation and willingness to negotiate.	Identification of issues and criteria is reasonable. Choice of weights and ratings usually includes difficult to impossible questions.	Many difficult responses are required even in a "simple" decision analysis process.
Role of facilitator	Project manager/orchestrator/mediator(?)/technical expert(?)	Interpreter of results/project manager/mathematician/technical expert(?)	Interpreter of results/project manager/mathematician/technical expert(?)
participants	Negotiator/preference selector/spokesperson for interest group/technical expert(?)	Issue and preference selector/reviewer/spokesperson for interest/technical expert(?)	Issue and preference selector/spokesperson for interest group/technical expert(?)
decision-maker(s)	Mediator(?)/representative of the public/final arbiter	Interpreter of results/political sanctioner of outcome	Interpreter of results/political sanctioner of outcome
Personal and group dynamics	Susceptible to disruption/control by dominant individuals but gives incentives to interest groups to participate openly	Compensates for strong groups and individuals but provides no guarantees to interests; Process is designed for many participants.	Compensates for strong groups and individuals but provides no incentive to interests; requires one-on-one questions and answers

TABLE 2. COMPARISON OF CHARACTERISTICS OF THE THREE METHODOLOGIES (Cont.)

	METHODOLOGY		
PROCESS CHARACTERISTIC	RG&H SITING PROCESS	DELPHI/NOMINAL GROUP PROCESSES USING WEIGHTED SUMMATION	DECISION ANALYSIS
Defensibility of the logic of the approach	Straightforward, common sense approach that systematically leads to decision, but some aspects cannot be completely justified mathematically	Numerical approach that requires several mathematical conditions to be conceptually correct; These conditions are usually not present or verified in a typical application.	Highly mathematical approach that includes verification of necessary conditions to be logically correct; However, verification complicates an already complex process.
Support requirements Information management	Requires comprehensive database and capability to analyze data quickly for entire region of interest, except in simple cases	Requires database on candidate sites or region (for regional screening) and program to calculate statistics on group responses and site scores	Requires database on candidate sites and program to calculate weights (scaling constants), utility functions, and site scores
Technical expertise	The process can be conducted at a basic level with minimal special expertise. More complicated steps require experienced individual.	Technical concept is simple but "number-crunching" capability is required for large groups or many alternatives. Experience is useful in interpreting results and promoting consensus.	Requires expert on decision analysis with technical support; Also requires sophisticated participants
Unique elements	Explicitly follows natural process to make a siting decision involving competing interests; Adapts to the scale of the siting problem; Specific areal reduction target for regional screening; Participants (interests) may have different objectives and criteria; Guaranteed representation of interests throughout process	Most widely used method for siting and multi-objective decision-making with the possible exception of exclusionary screening; Use of subjective weights and numerical suitability scores to rank sites/options	A common technique for making complicated management decisions that involve probability of and preferences for various possible outcomes Only process that incorporates risk.

entries in the table are certainly subjective and strongly reflect the interpretations of the authors.

Applicability. The key point of comparison among the alternatives lies in the determination of what part of a comprehensive site selection study can be handled by the method. Although both the RG&H and Delphi processes are applicable throughout, only RG&H Process activities are tailored to each phase of the site selection effort. The Delphi or Nominal Group process repeats or adapts essentially the same technique to select candidate areas and preferred sites. Decision analysis specifically addresses only the selection of a preferred site from a slate of candidate sites.

Quantitative vs. Qualitative Analysis. Although it is not exclusively so, decision analysis is clearly the most quantitative approach. The numerical scores are so scrupulously calculated that they have some mathematical significance. Delphi- or Nominal Group-generated weights and ratings are usually at best accurate enough to rank the sites properly, and it is usually not appropriate to attach much significance to the numerical magnitude of differences in site suitability scores. Therefore, the use of weights and ratings may imply a more quantitative and quantitatively sound method than actually exists.

The RG&H Process avoids numerical ratings in favor of a preference order or ranking resulting from trade-offs. However, as originally proposed, the regional screening phase is quantitative in that the composition of the region of interest must be described by specifying the area or portion of the siting region with each combination of criteria levels. This is so that it is known when each participant has made enough choices to identify his or her best n percent of the siting region.

All three methods will have quantitative aspects within individual criteria or attributes.

Subjectivity vs. Objectivity. The primary indicator of subjectivity in a siting process is the extent to which a participant can direct his or her responses and the process as a whole toward a preselected outcome (site). The RG&H Process is the most subjective because of the direct role of each participant in selecting their preferred areas and sites. However, the process maintains objectivity in a different way. Because each participant advocates one site or another yet no participant has a superior position in the process, the interest of each in protecting a position promotes mutually agreeable solutions and compromises that can be acted on objectively.

Yet because the overall decision may in fact be a political one, no process completely eliminates subjectivity. The RG&H Process presents siting options aligned with specific interests so that the ultimate decison-maker can subjectively favor certain factions. The other processes make this more difficult since the process elects sites and the decision-maker would be forced to strike out in a new direction in order to defeat the results of the process. In the other two methodologies, as long as the characteristics of specific sites are not completely known or as long as there are many criteria or attributes to consider, it is difficult for one participant to steer the results. Put in another way, if the process is complicated enough and decisions are made indirectly, it is practically impossible to subjectively select sites. By this standard, the more complicated decision analysis method is more objective.

Even within the most objective method there are many intermediate steps that are clearly subjective. For instance, the fact that a weight reflects one person's opinion of the relative acceptability of different situations makes it a subjective decision even though it is presented as a number.

Advocacy and Mediation. An advocacy approach as applied to siting means that identifiable interest groups openly act as proponents of options and form and carry out a strategy for their selection, obviously not an objective approach. Although in any of the three siting processes described, participants can favor certain options the mechanics of the last two processes prevent them from stridently campaigning for their preferences. This is a rather weak advocacy approach in comparison to the RG&H methodology.

The RG&H Siting Process uses advocacy as a driving force. An interest participates to voice its opinion directly and to advance its position relative to competing interests. In fact, this is the real nature of an "open" siting process. The agenda of each group is largely known and the process attempts first to identify solutions compatible to many different agendas. When this fails, mediation is necessary. Mediation is an effort to modify the options so that at least one becomes acceptable to all interests. Although mediation has been used to resolve conflicts for some time, it has recently been recognized as a way for both sides to win in an environmental dispute (Hair, 1983).

The Delphi and decision analysis approaches, taken purely as presented, use the process as a mediator without directly involving the participants as negotiators. In actual practice, individuals try to influence the outcome more than this and, if the outcome is unsatisfactory to enough of the participants, the selection procedure will be contested.

Reasonableness of the Participant Responses. All three processes ask difficult questions and require accurate responses in their attempts to assess the preferences of the participants. Clearly, a value judgement could be made about the type and number of reponses and their reasonableness, which itself varies with the participant as well as with the siting problem.

To contrast the three methodologies, it is assumed that questions directed at identifying objectives, issues, and criteria are always reasonable. It is also assumed that the questions involving the ranking or trading-off of two simple situations are reasonable. If this is not so, all three methodologies would be untenable and it would be difficult to conceive of a process that would be possible. However, as more or higher level trade-offs and questions regarding importance weights are introduced, there is less certainty that the process is still reasonable.

Table 2 reflects the preference of the authors toward a ranking approach over a weighting approach. It is our experience that it is easier to identify between two options than it is to say how many times more important one issue is than another or to answer the lottery-type questions required in decision analysis. In any of these methods the reasonableness depends partly on the skill of the process facilitator in directing appropriately worded and efficient questions. But it seems to depend more on the inherent difficulties in the type of responses solicited.

A subsidiary issue is the time allocated to the siting process by the participants and their commitment to it. Questions asked with proper introduction and preparation will always seem more reasonable than those hastily introduced and passed over. Often, representatives of important interests will not have the time to commit to several day-long sessions over a period of several weeks or months. In one recent Rogers, Golden & Halpern siting study the definition of the siting problem, the explanation of the selection of candidate areas, the process for selecting candidate sites, and the candidate site selection itself had to be completed within five hours including lunch, and even at that some participants left before the selection was completed.

Roles of Facilitator/Participants/Decision-maker. Each siting method places different responsibilities on the individuals and groups that are part of the selection procedure. In all of the methods, the facilitator manages the siting project and is responsible for details of organization, schedule, documentation of the process, and progress toward a result. This individual has a broad perspective on siting and siting methods and is especially familiar with the method proposed. In fact, the facilitator may be a proponent of a particular siting process. In all of the methodologies compared, the facilitator is not a participant per se in that their preferences for sites or trade-offs are not included and ideally are not even brought out. Also, in all of the processes the facilitator may have a dual role as technical expert on the type of facility being sited as well as on the siting procedure. The table 2 comparison foresees an individual as facilitator with technical support as necessary from others.

The RG&H Process places considerably more responsibility with the facilitator as an orchestrator and mediator as opposed to an interpreter of results as in the other two methods. The facilitator's role as orchestrator is designed to respond to the parts of the process in which the participants independently explore their preferences. The facilitator, who considers each interest individually and then brings the results together, is likely to also be a mediator resolving conflicts and pointing out compromises. The final decision-maker may feel that mediation is his role exclusively and take over this role from the facilitator.

In the other two processes under discussion, the facilitator is an interpreter of results. For example, in the Delphi process the facilitator determines when weights have stabilized and whether there is consensus, polarization, or chaos.

The primary role of the participants in each methodology is to give their preferences for various trade-offs that are made throughout the site selection process. The participants may be technical experts as well as spokepersons for the values of the interest they represent. In the RG&H Process, there is an advantage for groups to send their best negotiators, but in all processes it helps for the participants to be knowledgeable, articulate individuals, who have authority to make choices for the interests they represent.

Although participants in each process are certainly at some level decision-makers, the decision-maker whose role is described in table 2 is the one who chooses the final site. In the RG&H Process, this person usually has some room to maneuver, unless the process reaches an ironclad consensus. In the other processes, less latitude is available, so the decision-maker can usually only sanction or overrule the result. Depending on who has initiated the study, the decision-maker may have the political authority to make the choice or may be the proponent's principal spokesperson.

Personal and Group Dynamics. Any group effort, including site selection, is to some degree affected by the personalities involved. Because of the negotiation and advocacy characteristics of the RG&H Process, strong individuals or groups could control or disrupt it. The other processes control this tendency by maintaining anonymity of the participants at key stages.

The RG&H Process accommodates interest groups in a favorable way by guaranteeing that at least one candidate area and at least one candidate site will represent that group's viewpoint. This effort maintains involvement and committment to the process until the selection of a preferred site is achieved. The other methods treat groups differently in that they can select candidate areas in such a way that an interest group loses its incentive to continue with the process. And special interests are not dealt with separately so that the actual influence they have on the selection process is diluted.

Defensibility of the Logic of the Approach. This is actually the most difficult characteristic to compare because there are two competing standards for measuring the validity of a method. From a theoretical, mathematical viewpoint only the full decision analysis methodology can be completely justified, which is especially true if risk and uncertainty are important in the site selection process. The Nominal Group process requires certain assumptions to be true but they are usually not verified so that the mathematical correctness of the weights and ratings is in doubt. The procedures in the RG&H Process seek to avoid the heavily mathematical orientation and the burden of mathematical precision, but the way in which choices are made requires that the number of trade-offs necessary to make selections is manageable. This can only be verified mathematically and the process is potentially open to criticism in this area.

The second benchmark for defensibility is the reasonableness of the logic of the process with respect to the way that the decision should be or actually is made. In this context the agenda of the final decision-maker is important. If the purpose of the site selection process is to promote a consensus among competing interests, then the objectives of each interest should be identified and specifically addressed. A process that homogenizes issues will not be able to do this. Understanding of the method is crucial to this purpose. An approach that is theoretically correct but impossible to apply may be no more defensible than one that is conceptually flawed but easily implemented and targeted to the concerns of its audience.

Support Requirements. Siting efforts are data intensive and require accurate information and analysis. They also rely on technical expertise to characterize sites, create maps, and describe technologies and mitigation strategies in addition to implementing the more complicated steps in the methodology.

Assuming that the methodologies work with similar facilities and criteria, all three methods require similar support components in their technical and information management efforts. The current state of the art in siting uses some sort of geographic information system to consider a large amount of usually spatial data. Siting techniques that do not have the capability to analyze data quickly risk losing momentum. For example, using weighted summation, if the participants' weights cannot be summarized promptly, then the process is disrupted by waiting to proceed with the next round.

Typically the data mangement support requirements are much greater for the regional screening phase because data must be compiled and analyzed for the entire region of interest. For the selection of a preferred site the data is usally more specific and does not require mapping support on the level of the regional phase. The site-specific data can be assembled by site in advance of any siting session as needed for the process.

The technical support requirements include the expertise needed to apply the process and to manage the data. Much of this expertise should reside with the facilitator, but in simpler siting problems it may be desirable for the group to proceed as far as possible without experts. Each of the three methods requires some experience, but as is evident from the workshop exercise discussed earlier, the RG&H Process can be carried out by astute individuals who are familiar with the report. This is certainly not possible for decision analysis, and is probably not possible for the Delphi approach.

Unique elements. The discussion of the unique elements of the three methodologies is found in the conclusion section below. This last item attempts to summarize the process advantages as concisely as possible. The features of each process presented here are those that most distinguish the method.

CONCLUSIONS

Three siting methodologies have been described in sufficient detail to compare their major advantages and disadvantages for specific siting problems and purposes. All three must answer or avoid a logical sequence of questions regarding a facility, its effects, differences in these effects at specific places (sites), and preferences of the participants for specific outcomes. In addition, the process must answer fundamental questions about the agendas, objectives, and concerns of different interests in siting and their proper role in the siting process. Although the number of questions may seem large, they reflect the very nature of site selection. One could argue that these questions must be answered at least implicitly in any rational approach to siting. Generally, the questions lead to a series of steps. At the broadest level the processes have in common five major steps.

Siting processes differ in their basic philosophies and in their specific approach to answering the necessary questions. One basic contention of this paper, which is reflected in the philosophy of the RG&H Siting Process, is that siting is and ought to be based on advocacy. If the siting process is open to many competing interests (it has not yet been established in Canada that it should be), then their roles ought to reflect their differences. Although evident throughout this process, it is most present when participants, who represent different interests, initially base their decisions only on their own objectives and criteria. They find areas and sites that optimize their own position, they confront other positions, and if mutually satisfactory solutions do not exist, they identify the most likely possibilities. This leads to the modification of sites and facility characteristics until the political options are defined and referred to a political arbiter.

Whereas advocacy is the essence of the RG&H Process, consensus is at the heart of Delphi or Nominal Group process. In it, participants have considerable freedom in introducing issues and concerns, but the process is quite structured and inflexible in how participants specify their preferences and in how they are combined. One dilemma of this type of process occurs when the process stabilizes (i. e., weights do not change from round to round) yet their is actually no consensus. One democratic answer is to use average weights, but this further obscures the relationship between participants and the selection of a site. Another solution to the dilemma is to use the sensitivity analysis to reflect the effect of different weighting schemes, but this ignores the preferences of the participants. A related characteristic of this type of process is that participants do not directly deal with sites.

The Delphi or Nominal Group process assumes that the many issues that sites cannot be compared directly nor can trade-offs be made directly. Weights are the device to indirectly make trade-offs and compare sites. The experience of the authors is that attempts to derive valid weights from a Delphi session require many difficult questions to the participants that in some cases cannot conscientiously be answered. Opportunities for misunderstanding and misapplication of the weighting process are also possible.

The key concept of decision analysis is the incorporation of risk and preferences for outcomes in choosing sites. The technique is common in management decisions not related to siting, but in many instances these decisons have fewer issues and participants. The risk analyis component is primarily conducted by technical specialists. The assessment of preferences involves the participants and requires as much art as science.

The primary disadvantage of decision analysis in siting is its complexity, reflected in the intensity of the questions that must be answered and in the considerable expertise the facilitator must have. A corollary disadvantage is that not only is the method complex to apply, it is complex to explain: this requires either considerable faith or sophistication on the part of the participants.

The strength of decision analysis -- scrupulous attention to the mathematical details and all the possible conceptual considerations in making a decision -- is also its major disadvantage. To apply the method with typical participants in a siting procedure would require that it be simplified by limiting the number of issues and relaxing the verification of all the assumptions. It also requires a facilitator with the ability to convey the essence of the method and the wisdom to know which simplifications to make.

As does the Delphi or Nominal Group process, decision analysis does not deal directly with comparing sites; however, in the questioning process some trade-offs are confronted directly.

In addition to these primary differences in philosophy, the RG&H Process has other unique elements that are advantageous: the process follows what the authors feel is the natural direction and interaction of a decision involving competing interests; there are specific steps within the process that assess the siting problem and propose different responses depending on the scale of the problem and the nature of conflicts between competing interests; the process recognizes that the goal of regional screening is to reduce the region of interest and sets a target within the process for how much the area must be reduced. Lastly, the process provides a guarantee that the viewpoint of each interest will be wholeheartedly represented until the final decision.

All three methods have been applied to siting, although perhaps not exactly as described. They each have advantages and disadvantages for certain siting problems. On balance, however, the RG&H Siting Process has two overwhelming advantages: it recognizes that site selection is inherently a mediation of strongly advocated positions, and it is applicable at some level to a broad range of siting problems with minimal special expertise.

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NOMENCLATURE

attribute - in decision analysis, characteristics of the siting situation that are either selected from existing measures (such as cost or number of people) or are specifically constructed (such as indices of environmental impact or aesthetic degradation) to indicate the degree to which objectives are achieved.

combination of criteria levels - a collection of site attributes, including one attribute level for each criterion.

criterion - one standard or measure of performance on which a decision is partially based.

decision analysis - a systematic procedure for evaluating the attractiveness of alternatives based on the likelihood of possible consequences and the participant's preferences for the consequences.

decision-maker - the person or group ultimately choosing the site.

exclusion criterion - a criterion used by eliminating all potential sites below a certain level of performance regardless of the performance of the sites or areas with respect to other criteria.

facilitator - the organizer and director of the site selection effort.

inclusion criterion - a criterion used by including all potential sites above a certain superior level of performance regardless of the performance of the sites or areas with respect to other criteria.

participant - persons or groups asked to provide subjective inputs regarding their objectives and preferences for various trade-offs.

region of interest - the area, agreed to by the facility siting participants, that is the outer boundary of potential sites to be considered for the facility.

sensitivity analysis - in siting, a technique for comparing the effect of changes in weights, assumptions, and preferences related to the site selected by re-executing portions of the method with changes in these inputs.

scaling constant - in decision analysis, the equivalent of a weighting factor used to establish the relative utilities of two attributes.

siting team - persons or groups providing technical support for understanding the characteristics of the facility to be sited or for developing siting criteria.

study area - generally the same as the region of interest.

trade-off - a choice among situations not attainable at the same time.

utility - a concept primarily derived from economic theory that uses a numerical index to indicate the degree of satisfaction provided.

utility function - a numerical function, usually scaled from 0 for the worst alternative to 1 for the best alternative, that indicates relative preferences for intermediate alternatives and the participant's attitude toward risk.

SITING OF NATURAL GAS PROCESSING PLANTS IN ALBERTA

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ABSTRACT

Raw natural gas must be processed to remove hydrogen sulphide and other undesirable compounds before it is commercially used. Sour gas processing is a major industry in Alberta and one that is generating increasing public concern. Consequently, a thorough site selection program is becoming an increasingly essential pre-requisite for approval of a sour gas processing plant.

The goal of any site selection study is to find a site that is acceptable from technical, economic, biophysical, land use, social and political viewpoints. Study components include the development of selection criteria, data acquisition and mapping, candidate site selection, and site evaluation. This paper describes the site selection process, using illustrations from site selection studies that have been conducted for sour gas plants in southern Alberta.

INTRODUCTION

Raw natural gas typically consists primarily of methane and ethane with small quantities of propane, butane, and heavier (C_5+) hydrocarbons. Other constituents in a raw gas stream are water, hydrocarbon liquids or condensates, and, if the gas is from a sour field, hydrogen sulphide and carbon dioxide. A gas stream is technically considered sour if the hydrogen sulphide content exceeds 1.0 percent.

Raw gas must be processed in order that it meets sales gas specifications so that it can be safely used as fuel in residential, commercial, and industrial applications. Liquids, including water and condensates, must be removed and, if the gas is sour, hydrogen sulphide and carbon dioxide must also be removed. It is the latter category of processing that is of primary interest from a site selection viewpoint. Sour gas processing plants are usually larger, more elaborate facilities and engender air quality, public health, and public safety concerns.

To place the Alberta gas industry into perspective, in 1982, approximately 180 million cubic metres per day of natural gas was produced in Alberta by about 425 processing plants. Approximately 45 percent of the gas was produced from sour gas fields. In 1982, 23 percent of Alberta's sales gas was consumed in the province, 42 percent was delivered to other Canadian provinces and 33 percent was exported to the United States. Revenues from sales exceeded $6 billion.

On average, 97.5 percent of the sulphur present in raw sour gas was recovered in 1982. Sulphur is an important by-product of gas processing; in 1982, 5 million tonnes were produced, yielding sales revenues of about $600 million.

There are currently about 155 gas processing plants in Alberta which remove hydrogen sulphide from the raw gas stream; 53 of these plants recover sulphur. The remainder are smaller plants which generally combust acid gas at an elevated flare, a process which releases sulphur dioxide to the atmosphere.

There are several sour gas plants presently under construction or in the final planning stages; more plants will be required as gas markets improve in the future.

Our recent experience has shown us that public concern about sour gas processing will continue to increase. In addition, residential encroachment and other land use conflicts will continue to occur in areas with sour gas reserves. Consequently, a thorough site selection program will become an increasingly important component of planning a sour gas processing project.

This paper discusses approaches employed and methods utilized in a site selection study for a sour gas processing plant. These approaches and methods are illustrated where appropriate with examples from site selection studies for sour gas plants in southern Alberta.

BACKGROUND INFORMATION

Technical Requirements

Plant Site. A sour gas plant occupies about 10 to 30 ha of land. This is the fenced-in area that would include all on-site facilities. The plant site itself is larger, generally a quarter section of land (65 ha). The additional area is generally retained in agricultural use and helps protect against encroachment by conflicting land uses.

Major components of a plant site are the process area where raw gas is processed, utilities area to provide power and water for plant operations, the sulphur forming and blocking area, water storage and treatment areas, and an office/maintenance building.

One project variable that has considerable influence on site layout is the disposition of sulphur that is produced. At about 75 percent of plants, produced sulphur is shipped from the site in liquid form. At the other plants, generally the larger ones, liquid sulphur is formed or converted to slate, pellets, or prills, and subsequently shipped. Most plants have emergency storage blocks. If no readily accessible market exists for the produced sulphur, it is poured onto a block where it solidifies. Relatively large sulphur blocks exist at some of the plants in the province; these blocks have generally been reduced by a remelting process in recent years as sulphur markets have improved.

Off-Site Facilities. A processing plant does not exist in isolation. It is connected to its source of raw material by an intricate system of gathering pipelines that bring raw gas from nearby wells to the plant and to its market by a sales gas pipeline. Often field facilities such as compressors, dehydrators, and injection wells are also required. Site selection for a gas processing plant must take the entire project configuration into account.

Road access is essential for plant construction and operation; rail access is generally not essential but is desireable for larger sulphur-producing plants. An external power supply is desireable, but in remote locations power can be obtained by on-site steam generators. Water requirements for a modern air-cooled plant are not large and can either be supplied by an on-site well or piped or trucked from an off-site source.

Regulatory Requirements

The gas processing industry is highly regulated and operating plants must meet strict sulphur recovery, atmospheric emission, and liquid effluent discharge standards. From a project planning perspective, a comprehensive environmental impact assessment is generally required for a new sour gas processing plant. Main areas of concern in impact assessment are air quality, land use conflicts, and social issues. As a result of increasing public concern about health implications of low-level emissions of sulphur dioxide and other trace elements that may be emitted, acid rain, and the consequences associated with release of hydrogen sulphide from a well blowout or pipeline rupture, a thorough public involvement program must accompany any impact assessment for a sour gas facility.

APPROACH TO SITE SELECTION

The goal of any site selection study is to find a site (or alternative sites) that satisfies the following:

- Acceptable from a technical viewpoint, considering project and site servicing requirements.
- Acceptable from an economic viewpoint, considering land prices, site development costs, and site servicing costs.
- Avoids or minimizes biophysical impacts and land use conflicts.
- Acceptable from a social and political point of view.

Components of a comprehensive site selection study are as follows:

- Development of site selection criteria.
- Acquisition and mapping of baseline data.
- Selection of candidate sites through a composite or overlay mapping approach.
- Evaluation of candidate sites and specification of preferred sites.

SITE SELECTION CRITERIA

The first stage of a site selection study is to develop selection criteria. These criteria should be comprehensive. They will be used in defining the study area, selecting alternative sites within that area, and evaluating these sites.

Technical/Economic Criteria

Technical and economic criteria are developed first. These criteria are the primary ones used in defining a study area. A gas plant must be situated in close proximity to the gas reserves. To do otherwise would be uneconomic and, in the case of sour gas, pose much greater safety risks to the public because of increased pipeline length. At the other extreme, a manufacturing plant that produces consumer goods must be close to markets and a large community capable of providing or attracting specialized labour.

Technical and economic criteria are usually combined; there are very few cases where it would be technically impossible to construct and operate an industrial plant on a given piece of property. Therefore, cost becomes a primary factor.

Table 1 presents typical technical/economic criteria for a gas plant site selection study. Proximity to the weighted centre of natural gas reserves is by far the most important technical/economic criterion. Pipeline capital and operating costs are much higher to transport raw gas than to transport sales gas. This cost differential becomes greater as the gas becomes increasingly sour.

TABLE 1

TYPICAL TECHNICAL/ECONOMIC CRITERIA: NATURAL GAS PROCESSING PLANT SITE SELECTION

Criteria	Importance Rating	Comments
Proximity to weighted centre of gas reserves	High	As distance from centre increases, capital and operating costs increase due to additional gathering system pipeline and field compression required.
Availability of suitable, all-weather road access	High	A suitable road is required for construction and operations access. By-products such as sulphur and condensates may be trucked from the site.
Proximity to rail access	Low to High	Depends on volumes and marketing arrangements for plant by-products. Rail shipping is highly preferable for large quantities of sulphur.
Proximity to sales gas connection	Medium	Project capital and operating costs increase with increased distance.
Minimize site development costs	Medium	Development costs are higher at sites with rolling topography, elevation gradients, or low-lying areas, and at sites with geotechnical problems such as poor load-bearing capacity or drainage problems.
Availability of electrical power	Low to Medium	Depends on plant power requirements.
Proximity to delivery points for by-products pipeline from site	Low	Project capital and operating costs increase with increased distance.
Availability of water supply	Low	If an adequate supply cannot be obtained on site, water must be pipelined from an off-site source.
Minimize stack heights	Low	Higher incinerator and other stacks are required if the site is close to major hills or other emission sources.
Proximity to urban centres	Low	Proximity to urban centres will improve access for construction and operations personnel, service contracting, and material and equipment supplies.

Importance of these criteria is rated as high, medium, or low, based primarily on capital and operating cost considerations. In most site selection studies, the importance rating is further elaborated to more precisely reflect differential costs appropriate for the project under consideration.

Criteria such as availability of construction and operating labour and suitable urban infrastructure in the region, which have high importance in site selection projects for other types of facilities, have very low or no importance in gas plant site selection studies because the size of the study area is limited by the location of gas reserves.

Biophysical Criteria

Biophysical site selection criteria are developed specifically for each project, depending on the study area under consideration. In the case of gas plants, where the study area is often defined by the boundaries of gas reserves, the number of criteria is generally minimized due to the uniformity in biophysical environment throughout this relatively small area.

Typical biophysical criteria are listed in Table 2. Importance ratings for these criteria reflect both the difficulty of mitigating potential biophysical impacts and the difficulty involved in selecting a site with appropriate biophysical attributes within the study area. As described previously, importance ratings provided in this table are general; they would be further elaborated for a specific project.

Two observations should be made. First, there is some overlap and positive reinforcement between the technical/economic criteria and biophysical criteria. For instance, locating a plant in a fairly flat, dry area satisfies technical/economic criteria of minimizing site development costs and minimizing stack heights. It also satisfies biophysical criteria of avoiding unsuitable surface conditions and locating away from major hills.

Second, the tradeoffs required in site selection are becoming apparent. For instance, a flat, dry site may be prime agricultural land. This may be acceptable where the agricultural capability is generally high throughout the study area and the plant is small. However, it may not be acceptable in areas where there are only pockets of high quality agricultural lands or areas where soils are susceptable to acidification, and a large plant with a sulphur blocking or forming operation is contemplated. The importance assigned to this criterion would be rated appropriately to reflect these two cases.

Land Use Criteria

Land use criteria are also developed specifically to reflect project details and study area characteristics. Typical criteria are presented in Table 3. Importance ratings for these criteria reflect the difficulty of mitigating land use impacts and the difficulty of selecting a site with appropriate land use attributes within the study area. To the extent that public attitudes are known, they will be considered when assigning importance ratings. For example, in some areas visual impact is a primary concern of residents. In others, safety hazards posed by sour gas pipelines is a primary concern.

The volume of sour gas that could potentially be released during a pipeline rupture or well blowout must be considered when assigning importance ratings to land use criteria. Levels are assigned to sour gas facilities on the basis of potential realease volumes. These levels will dictate what setbacks are required from residential areas and public facilities and consequently, what lands are alienated from development as a result of the establishment of sour gas facilities.

TABLE 2

TYPICAL BIOPHYSICAL CRITERIA: NATURAL GAS PROCESSING PLANT SITE SELECTION

Criteria	Importance Rating	Comments
Avoid unsuitable surface conditions (steep slopes, wet areas)	High	A relatively flat, dry site will minimize site preparation (clearing, grading, filling) and result in fewer drainage and erosion problems.
Locate away from major surface water bodies	High	Avoiding rivers, major streams and lakes will minimize erosion problems, reduce flooding risk in flood-prone areas, and minimize the potential to contaminate water bodies in the event of a spill.
Locate away from major hills	Medium	Major hills close to the site may result in potential air quality problems.
Avoid high capability agricultural lands	Low to High	Avoid Class 1, 2 or 3 lands where lower quality lands are economically accessible. More important for large plants, particularly those that block or form sulphur.
Avoid key wildlife habitat areas	Medium	Avoid areas critical to the life cycle of any species that cannot tolerate disturbance.
Avoid pipeline crossings of major rivers or streams	Medium	Steam crossings cause erosion/siltation problems and may endanger aquatic life.
Minimze length of new pipelines required	Low	Pipeline construction can result in biophysical impacts such as erosion, habitat removal and disturbance of productive agricultural soils.

TABLE 3

TYPICAL LAND USE CRITERIA: NATURAL GAS PROCESSING PLANT SITE SELECTION

Criteria	Importance Rating	Comments
Minimize residences in site vicinty	High	Considerations include public safety; minimizing impacts due to noise, traffic, and odours; and avoiding public opposition.
Locate away from residential subdivisions and urban areas	High	See above considerations. In addition, plant location will restrict residential subdivision or urban expansion.
Avoid areas where high visual impact would result	Medium to High	Consider the natural setting, primary land uses, orientation and character of surrounding residences, and public attitudes.
Minimize length of any new sour gas pipelines required	Medium to High	Sour gas pipelines pose public safety concerns and impose residential and other development restrictions.
Avoid highly productive farming units	Medium	Agricultural impacts will be more significant if a plant were located on or adjacent to a highly productive farm. Also land options may be more difficult or expensive to secure.
Avoid recreation areas and land with high recreation capability	Medium	Avoid public and private recreation facilities and important resource-based recreation areas or potential areas.
Conform to municipal/regional zoning designations	Medium	Avoid areas where a gas plant would not be a permitted or discretionary use. Amendments to plans or land use by-laws are often time consuming and risky.
Avoid productive mineral extraction areas	Low to High	A plant and associated infrastructure may preclude or restrict certain mineral extraction activities, particularly surface mining.
Avoid productive timber harvest areas	Low	A plant and associated infrastructure may hinder forestry operations.
Consider land ownership patterns	Low	In some areas, it may be possible to avoid high land costs and secure options more readily by selecting certain types of lands.

Minimizing residences in the site vicinity is typically the highest ranked land use criterion. Apart from impacts that cannot totally be mitigated, such as noise, odour, traffic and visibility, there is the prevalence of "NIMBY" (or not-in-my-back-yard) syndrome. To many people, any change, particularly when there is some uncertainty associated with it, is not welcome.

The second and third criteria overlap somewhat with the first criterion. However, each are worthy of including on their own merits. For example, a site may be reasonably close to a residential subdivision, but may be sufficiently screened by topographic or vegetative features that visual impact is minimal.

Consideration of land ownership patterns is ranked low, although securing a land option at a reasonable cost is an extremely important aspect. Successful application of other land-use criteria should produce a site that avoids prime residential, agricultural, recreational and industrial areas. This should serve to minimize land costs. Uncertainty about the ability to secure land, however, will generally remain until the land acquisition process starts.

Social and Political Criteria

Social and political considerations are the most difficult to incorporate in a site selection study; yet, they are perhaps the most important. Failure to take proper cognizance of social and political factors may result in the project being turned down. At best, it can result in often lengthy and costly delays in the project approval process.

There are two recent examples in Alberta of gas plants not receiving municipal government approval for reasons primarily related to plant siting, even though those plants were approved at the provincial level. There are many more examples where lengthy delays have occurred.

Public attitudes are difficult to assess during site selection since almost all project proponents prefer not to disclose their intentions until they have secured options on a plant site. Without public disclosure, the best way to gain an appreciation of public attitudes is to rely on key individuals in the study area who can be relied on to maintain confidentiality.

In some cases, the project proponent is a newcomer in the area and very little industrial development has occurred. There may be no effective way of gaining insight into public attitudes until the proponent discloses its intentions and the public have an opportunity to respond.

Relevant political considerations are generally at the municipal government level. Unlike other industrial site selection studies, where government policies encouraging economic decentralization or tax sharing may be considerations, a gas plant must be located where the reserves are. There are some interesting exceptions, for example where a gas field extends under an Indian Reserve, or across a provincial boundary. Generally, however, a proponent will be dealing with one municipality - a rural municipality.

A proponent must decide whether to approach a muncipal council during the site selection process or wait until a site is procured and a public announcement is imminent. Most proponents choose the later route, feeling that if they select a good site and conform to the municipal zoning designation, the municipality should have no objection. While this is generally true, history has shown that in many cases it might have been advantageous to brief a municipal council during the site selection process.

In summary, every reasonable effort should be made to elicit attitudes from the public and elected representatives. A proponent must, of course, decide how soon and how far to go in disclosing its intentions before sites are optioned; whatever the decision, there are associated risks. Attitudes that are obtained, if they are representative, should be afforded considerable weight in development of site selection criteria and in assigning importance ratings to these criteria.

SITE SELECTION

Data Acquisition

Representative data requirements for the major groups of criteria are listed in Table 4. These data will all be needed if an environmental impact assessment is ultimately required for the project. Thus, complete and up-to-date data should be acquired, where available.

Selection of Alternative Sites

Two major approaches to site selection are commonly employed: the Composite Mapping Approach and the Overlay Approach. Most studies use some variation or combination of these approaches.

The Overlay Approach follows an iterative process, identifying areas first on the basis of the most highly ranked criteria, then fine tuning these areas using all criteria. An example of this approach is illustrated in Figure 1. This topographic constraints map is from a site selection study conducted for Western Decalta Petroleum (1977) Limited in the Turner Valley area, southwest of Calgary. The area is a transition zone between grasslands and foothills terrain and topography was an important consideration in site selection. Similarly, residential land use, as illustrated in Figure 2, was an important consideration. These two maps, along with others illustrating other important criteria, were used in the process of selecting eight candidate sites.

For the Composite Mapping Approach, constraint areas are identified for each important criterion and then combined to provide an overall composite constraint map as illustrated in Figure 3. This composite map is from a site selection study conducted for Phillips Petroleum Company Western Hemisphere in the Morley area west of Calgary. Particularly important, and somewhat unique, issues in this study were aesthetics, road transport of sulphur, and sharing of resource revenues among the Alberta Crown, Federal Crown, private residents, and the Stoney Indian Band.

The number of candidate sites selected will depend on the size of the study area, the variety of conditions found throughout it, and difficulties encountered in satisfying all highly ranked criteria. In general, the number of candidate sites is between five and ten.

Site Evaluation and Preferred Site Selection

At this stage of the study, there are about five to ten candidate sites. These sites must be evaluated and a preferred site or sites selected. Each criterion used in site selection will be employed in site evaluation. Pertinent information will be assembled for each site, generally in tabular form as illustrated in Table 5.

The next step is to use this detailed information in ranking the candidate sites. This is most effectively accomplished using a matrix approach, as illustrated in Table 6. This table incorporates one important representative criterion from each of the major groups.

TABLE 4

DATA REQUIREMENTS: NATURAL GAS PROCESSING PLANT SITE SELECTION STUDY

TECHNICAL/ECONOMIC CRITERIA

- Location of gas reserves, areas of possible future expansion
- Location of existing and potential wells
- Raw gas characteristics
- Proposed plant size and operating life
- Marketing arrangements and locations for sulphur, condensates, and other by-products
- Sales gas connection point
- Location, capacity, and expansion/upgrading plans for transportation infrastructure
- Location and capacities of other oil and gas infrastructure
- Locations and capacities of electrical power service
- Ground-water yields

BIOPHYSICAL CRITERIA

- Topographic maps
- Land capability for agriculture maps
- Land capability for wildlife and key wildlife habitat maps
- Personal communication with wildlife and fisheries biologists to determine critical areas and regional concerns
- Plant emission details
- Presence of sulphur block or sulphur forming capability

LAND USE CRITERIA

- Municipal land ownership map
- Boundaries of urban areas and residential subdivisions and areas of future expansion
- Regional and general municipal plans; municipal land use by-law
- Height of plant incinerator stack and major plant buildings
- Expected level of sour gas pipelines
- Inventory of recreation facilities and important recreation areas
- Land capability for recreation maps
- Inventory of existing mineral extraction and forestry operations; future potential for these activities
- Field inspection to assess topographic constraints, agricultural operations, residences, visual considerations, recreation areas, and industrial activities.

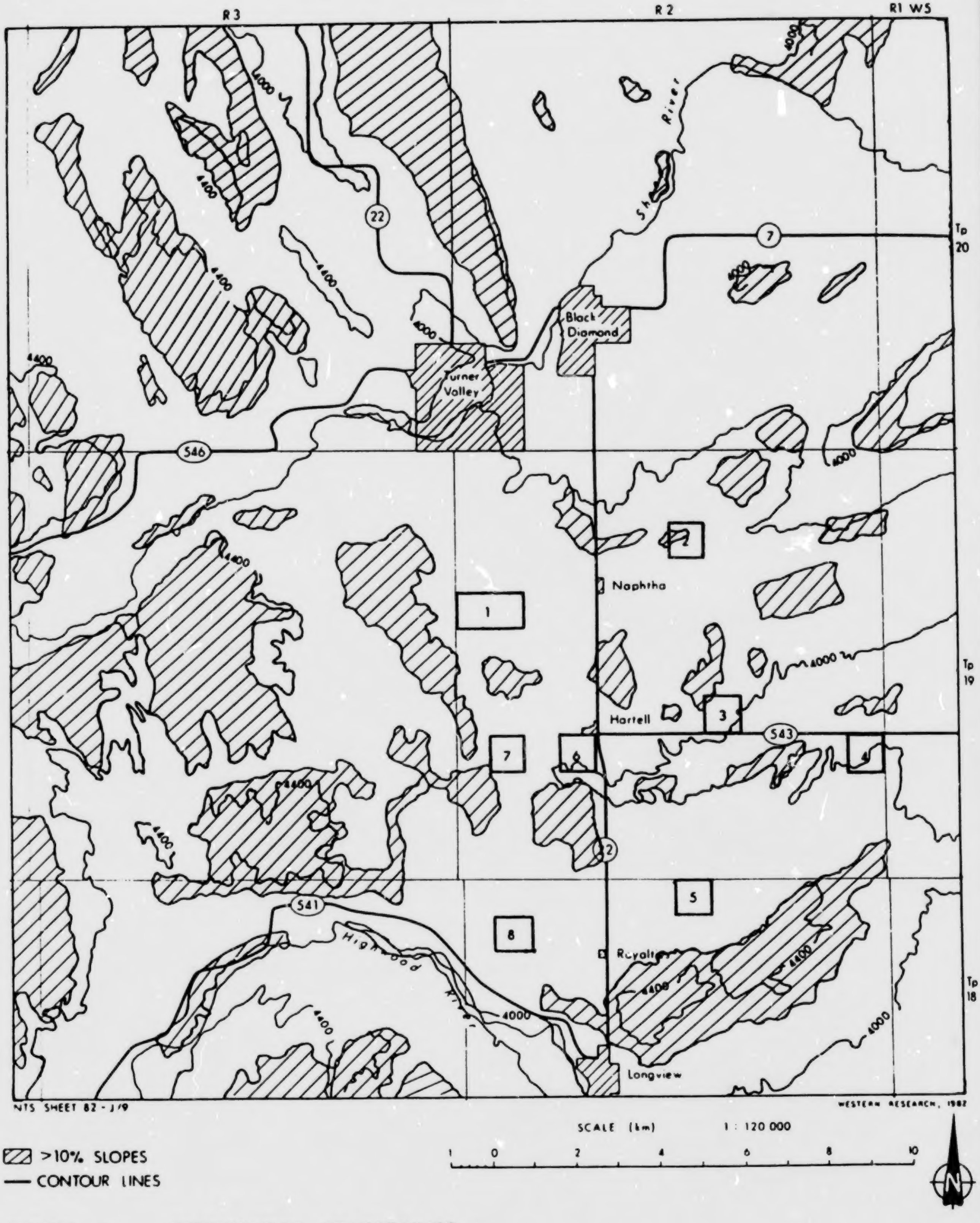
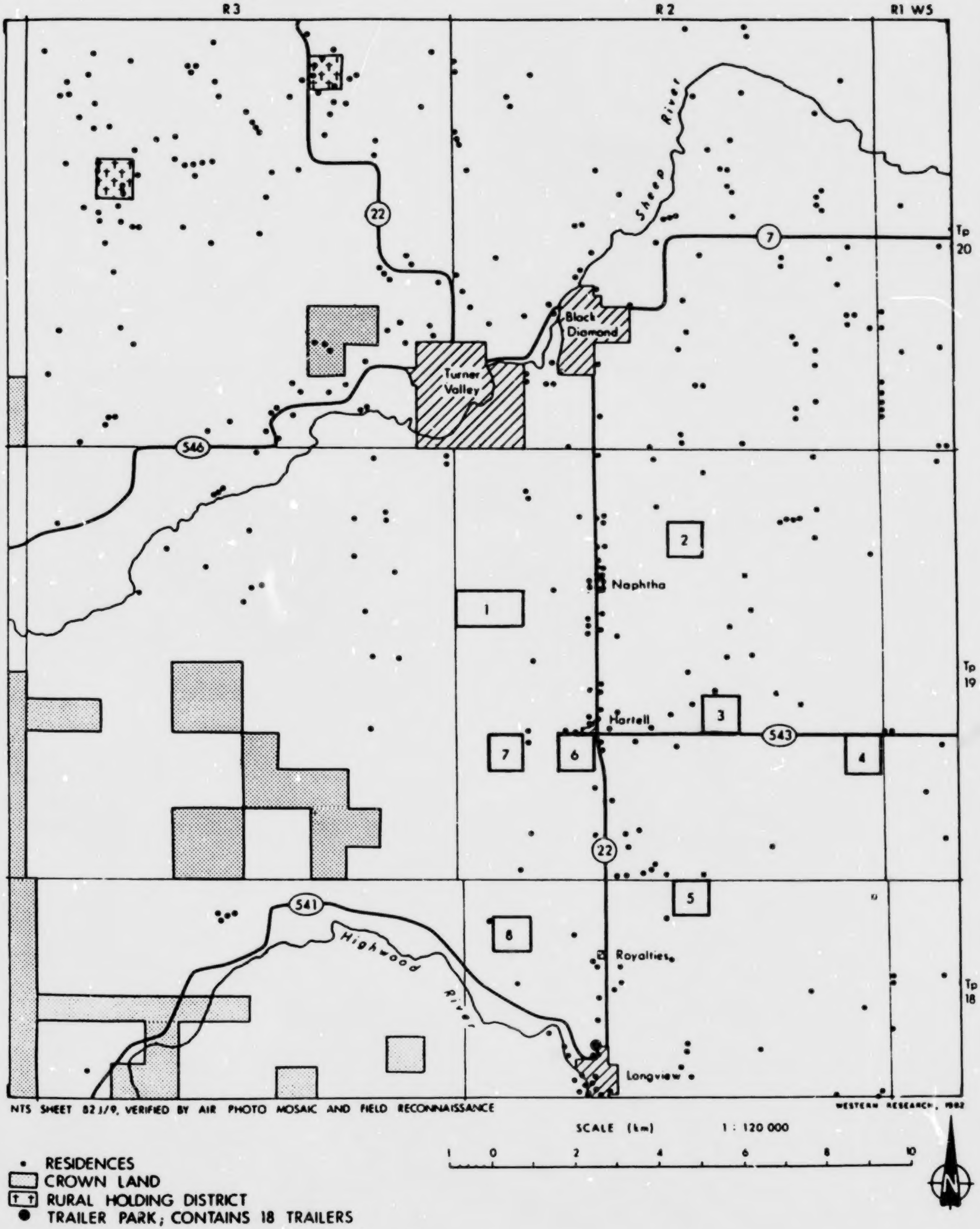

R 3
R 2
R1 W5
Tp 20
Tp 19
Tp 18
22
7
546
543
541
Sheep River
Highwood River
Turner Valley
Black Diamond
Naphtha
Hartell
Royalty
Longview
4000
4400
1
2
3
4
5
6
7
8
NTS SHEET 82 - J/9
WESTERN RESEARCH, 1982
SCALE (km)
1 : 120 000
1
0
2
4
6
8
10
N
▨ >10% SLOPES
— CONTOUR LINES

FIGURE 1 TOPOGRAPHIC CONSTRAINTS


R3
R2
R1 W5
Tp 20
Tp 19
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546
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Sheep River
Highwood River
Black Diamond
Turner Valley
Naphtha
Hartell
Royalties
Longview
1
2
3
4
5
6
7
8
SCALE (km)
1 : 120 000
1 0 2 4 6 8 10
N
• RESIDENCES
CROWN LAND
RURAL HOLDING DISTRICT
● TRAILER PARK; CONTAINS 18 TRAILERS

NTS SHEET 82J/9, VERIFIED BY AIR PHOTO MOSAIC AND FIELD RECONNAISSANCE

WESTERN RESEARCH, 1982

FIGURE 2 RESIDENTIAL LAND USE

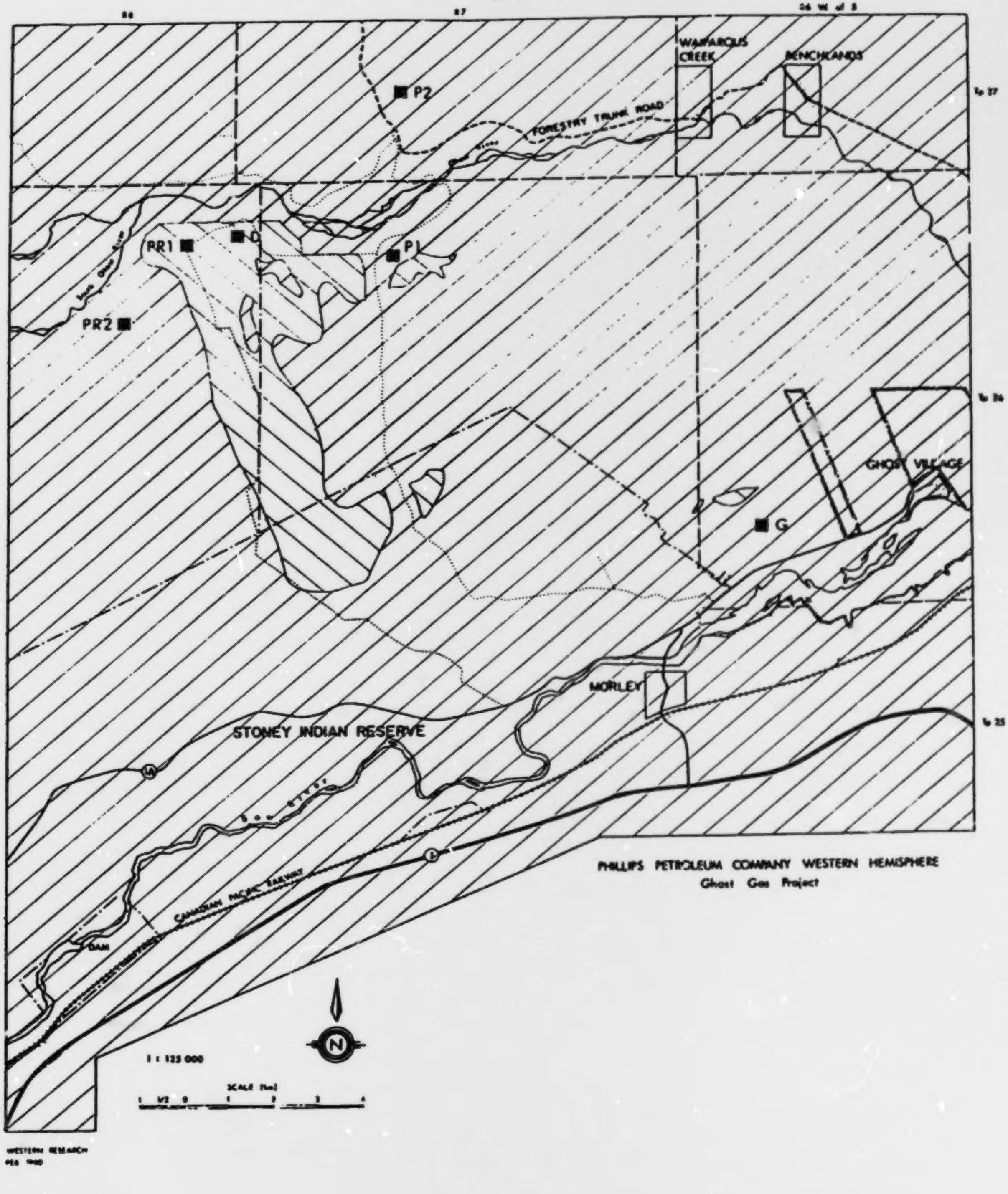
88
87
26 W. of 5
WAIPAROUS CREEK
BENCHLANDS
Tp 27
P2
FORESTRY TRUNK ROAD
PR1
O
P1
PR2
Tp 26
GHOST VILLAGE
G
MORLEY
Tp 25
STONEY INDIAN RESERVE
1A
Bow River
1
CANADIAN PACIFIC RAILWAY
DAM
N
1 : 125 000
SCALE (km)
1 1/2 0 1 2 3 4
PHILLIPS PETROLEUM COMPANY WESTERN HEMISPHERE
Ghost Gas Project
WESTERN RESEARCH
FEB 1980

FIGURE 3

COMPOSITE RESOURCE MAP FOR GAS PLANT SITE SELECTION PURPOSES

▨ MAJOR CONSTRAINT
▧ MINOR CONSTRAINT

TABLE 5

REPRESENTATIVE SITE COMPARISON

Factor	Candidate Sites A	 B	 C	 D	 E
Distance to centre of gas field (km)	3	10	5	12	1
Capability for agriculture (CLI Class)	75%-2 25%-3	80%-4 20%-3	60%-5 40%-4	50%-3 50%-2	70%-5 30%-6
Residences with 5 km of site	20	3	10	12	30

TABLE 6

REPRESENTATIVE SITE RANKING: ORDERED APPROACH

Criteria	Candidate Sites A	 B	 C	 D	 E
Proximity to weighted centre of gas reserves	2	4	3	5	1
Avoid high capability agricultural lands	5	3	2	4	1
Minimize residences in site vicinity	4	1	2	3	5

Note: 1 = Best Site
2 = Worst Site

The ordered approach illustrated in Table 6 is the simplest method of site ranking. The five candidate sites are ranked from one to five, according to how well each site satisfies the criterion.

An alternate site ranking method, which can be called the proportional approach, has also been employed. For a particular criterion, a score of ten is assigned to the best site and a score of zero to the worst site, with intermediate scores proportional to quantifiable differences among sites.

Both approaches have their drawbacks. The ordered approach uses a uniform gradient between ranks assigned to each site and this may either over emphasize or under emphasize site differences. The proportional approach may be more representative for an individual criterion, but considerably greater difficulties arise in attempting to combine scores to provide an overall rank. For this reason the ordered approach is generally preferred.

The next step is to produce an overall rank for each site. Table 7 illustrates how this can be accomplished utilizing importance ratings for each criteria. Typically, a site ranking table would be developed for each group of site selection criteria. Overall scores would then be calculated and overall ranks assigned for each group, as illustrated in Table 8.

It is somewhat arbitrary to simply add the ranks for each group of criteria, since this implies that technical/economic, biophysical, and land use criteria have equal weighting in determining the overall rank. However, it is often done to obtain an overall picture. On the basis of Table 8, Site D would clearly be selected as the preferred site, with Site A as a primary alternate site.

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TABLE 7

REPRESENTATIVE SITE RANKING: ORDERED APPROACH, INCORPORATING IMPORTANCE RATINGS

Criteria	Importance Rating Factor	Candidate Site Scores[1]				
		A	B	C	D	E
Proximity to weighted centre of gas reserves	5	10	20	15	25	5
Avoid high capability agricultural lands	3	15	9	6	12	3
Minimize residences in site vicinity	4	16	4	8	12	20
Total Score	-	41	33	29	49	28
Overall Rank	-	4	3	2	5	1

[1] Product of ordered site ranks from Table 6 and importance rating factor.

TABLE 8

SITE RANKING SUMMARY

Criteria Group	Candidate Sites				
	A	B	C	D	E
Technical/Economic	2	5	4	1	3
Biophysical	2	1	4	3	5
Land Use	2	3	4	1	5
Total Score	6	9	12	5	13
Overall Rank	2	3	4	1	5

Note: 1 = Best Site
5 = Worst Site

SESSION I B - OVERLAND ROUTING

PLANNING AND PRESENTATION: DOMINANT CONCERNS FOR EFFECTIVE COMMUNICATION IN ENVIRONMENTAL DOCUMENTS

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ABSTRACT

Recent emphasis on public participation in project decisionmaking has underscored the critical role of the environmental document in effective communication of environmental impact assessment (EIA) findings. We propose a planning approach whereby the EIA is prepared based on the document needs. Key planning elements are: first, identify factors which influence the EIA process, and, second, create a strategy for structuring the document. Strategies such as the multiple-format concept and the hierarchical-tier approach can enhance communication of findings.

INTRODUCTION

Enactment of environmental legislation such as the National Environmental Policy Act (NEPA) stimulated development of numerous facility siting and environmental impact assessment (EIA) methodologies during the 1970's. Discussion and debate on this topic in the professional literature mirrors this trend. Methods and assessment capabilities have become increasingly sophisticated. The past few years have also seen a heightened public awareness of issues and effects related to agency proposals. The focus of methods development may now be shifting toward refining ways to enhance public participation in the assessment and decisionmaking process.

Numerous methodological reviews during the past decade have evaluated environmental impact assessment techniques against specific criteria useful in assessing the utility of methods. Examples include: Bisset, 1980; Clark et al., 1980; Lee, 1980; Jain, et al., 1977; and Warner and Preston, 1974. Use of public involvement as a measurement criterion has gained prominence in these critical reviews. However, a key link between the analysis of impacts and the involvement of the public may not be receiving adequate consideration. That link is the communication of findings in environmental documents.

In an earlier paper (Bisenius and Marcotte, 1982) the authors performed a critical review of currently-used environmental impact assessment methodologies. We concluded, as others have, that while most of impact assessment methods yielded acceptable results, it was often difficult to understand what was being presented in environmental documents. We stated then that no methodology which frustrates or confuses the communication of its findings can be considered successful. The result can be a paradox: adequate technical conclusions may have limited utility because they are not communicated effectively.

Because the emphasis on public participation has made the effective communication of study findings even more critical, we feel that it is appropriate to examine ways of communicating the findings of project analyses. We are focusing discussion on the environmental document because it is an end-product which represents the synthesis of analysis and communication activities; thus, it is a crucial vehicle of communication. This paper illustrates a set of approaches that has evolved over the past several years in our work.

First, to provide perspective, we discuss pertinent aspects of the environmental impact assessment process, including communication. We then discuss basic elements of the overall planning approach which typically guides the process. Next, we illustrate specific ways the general planning process can be applied to document planning in order to set the stage for effective communication of study results. Finally, we examine specific strategies and techniques for planning and structuring an environmental document which can help ensure full transmission of findings. The discussion deals with transmission line projects, although the approach should be applicable to any linear facility.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) PROCESS

Much has been written on what environmental impact assessment (EIA) is, what it should be, and how best to do it (Porter and Rossini, 1981; Bacow, 1980; Hollick, 1980; Nair and Sicherman, 1979; O'Riordan, 1979). In the broadest sense, EIA is the evaluation of possible consequences of proposed projects, programs, or policies. A primary purpose of EIA is to assist the decisionmaker in choosing among alternatives. To this end, the process has evolved into a series of related tasks. Based on the above literature, typical tasks include:

- identifying project alternatives, project characteristics, and environmental parameters to be examined;
- siting transmission line corridors and/or routes;
- identifying and quantifying possible impacts along the route options;
- predicting and assessing the intensity, duration, probability, and significance of the project's effects;
- evaluating and comparing alternatives based on their impacts and the preferences of involved parties;
- communication among involved parties throughout the process and transmission of study findings.

It is apparent that involvement of the affected public has increasingly become an inherent dimension of EIA tasks, as reviewed in the next section.

ROLE OF COMMUNICATION IN THE EIA PROCESS

The role of communication in the EIA process has undergone significant changes in scope in recent years. The traditional view held that communication is limited to consultation, particularly with the general public, during the latter stages of the process, commonly after the impact study was completed (Lee, 1980). This approach tended to set up adversarial relationships between project proponents and project opponents. Studies were prepared to be defendable. This approach did little to advance the goal of making quality and acceptable decisions.

More recently, the trend has been for early and active public participation throughout the EIA process. Although NEPA implementing regulations (Council of Environmental Quality regulations: 40 CFR 1500-1508) require public participation in the assessment process during only two phases (Scoping and Draft EIS review), responsive federal agencies are attempting to carry out an ongoing exchange of ideas and information with the publics in developing their proposals. Such policies recognize that "public views on the formulation of proposals and the acceptability of projects are important aspects to be considered in planning and decisionmaking" (Bisset, 1980). The overall goal of communication within the EIA process today seems to be: involve interested parties in the entire assessment process "to enable them to make effective contributions to the quality and acceptability of environmental decisionmaking" (Lee, 1980).

The scope of this expanded public role would range from pre-study (generating alternatives, identifying major issues) through impact analysis (providing data input to impact assessment models) and finally to formal review of draft documents (Lee, 1980). This expanded concept of interactive communication advances the goal of making good decisions because it affords affected publics the opportunity to play a wider role in influencing decisions that will affect them. This conclusion is based on the premise that a prime measure of how good a decision is is its acceptability to all involved parties. If it follows that the EIA process must now be seen "as part of a political process involving a variety of different political actors . . . including the proponent, local people and national interest groups" (Bissett, 1980), then it also follows that effective communication among these actors becomes paramount.

What is the role of the environmental document in such a communication scheme? Primarily it serves to transmit project information. But in doing so, it assumes much broader significance. It is perhaps the critical juncture on the path of the EIA process. It synthesizes the results of all siting studies, impact assessments, and public involvement activities that have contributed to the development of the proposal and alternatives. It is the primary visible evidence of a proponent's work on a project, and therefore, a key vehicle of communication. For these reasons, the quality of previous project activity is largely judged by this document. If the document fails to communicate effectively, the subsequent acceptability of the project decision--indeed the project itself--may be jeopardized.

Yet there is ample evidence that often documents do fail to transmit study results clearly and understandably. Major criticisms pertaining to how well environmental documents communicate include:

- They can be too encyclopedic (too comprehensive)--they analyze too many impacts, including many that are not relevant--hence, they can become burdened by extraneous descriptive text and fail to provide the knowledge necessary for effective participation.
- They can be too complex--they focus heavily on scientific and economic topics that are beyond grasp of the general public. They are written by technical personnel for their peers, not for the public (Bender and Clink, 1978; Bisset, 1980; Bacow, 1980). Thus, they are not full disclosure documents.
- They often don't analyze enough impacts (not comprehensive) (Bacow, 1980); they fail to address concerns in sufficient depth.

Despite general agreement that it is the document that is often inadequate, the brunt of corrective action seems to be to improve the EIA process itself. We would be among the first to agree that refining the process is a laudable and necessary pursuit, and that improving analysis and participation approaches will yield better documents and better decisions. However, we propose that corollary efforts directed specifically towards producing more effective documents can also notably improve communication in the EIA process. Any effort to design an improved communication document must begin with planning.

EIA AND DOCUMENT PLANNING

EIA planning operates within and is part of the overall project planning process. Planning guidelines specify first determining study goals and objectives, then detailing the steps necessary to accomplish them. Good planning approaches set early planning objectives and offer flexibility: they allow for midcourse adjustments due to changing circumstances, public feedback, new alternatives, and other project changes. Because the environmental document is a key element in the EIA process, planning specifically for its preparation assumes major importance. The overriding theme of document planning, then, is to correlate the preparation of the assessment with the specific transmission of its findings. Although this may seem to be implicit, the degree to which it is performed consciously and according to a thought-out procedure bears strongly on the success of the document as a communication tool.

The authors have developed and applied successfully a two-phase planning approach. The first phase examines factors which limit, determine, or otherwise influence the communication process. It involves identifying and evaluating determinants and goals of EIA and environmental documents. Basically, this step entails:

- identifying study findings to be transmitted in the document;
- evaluating factors which shape or bound the EIA process, and which, therefore, strongly dictate the content and format of the document;
- examining communication goals and objectives which follow from the above factors and guide the process.

The second phase involves incorporating the results of the first phase into a comprehensive strategy for structuring a document. Steps in this phase include:

- defining the range of presentation formats available for printed media, and evaluating their strengths and limitations;
- integrating the presentation formats in complementary ways to structure the document.

PHASE I - DETERMINANTS AND GOALS

Transmission of Findings

A common-sense place to start the planning strategy is to identify the study findings. The study findings disclosed in a document correlate to basic EIA tasks discussed earlier. Environmental documents generally contain: descriptions of the proposal and alternatives to it; the environment that will be affected; the nature and significance of the effects on the environment; the means to ameliorate these effects; and a comparison of the alternatives based on the impact conclusions and the preferences of the involved parties.

EIA and Document Planning Determinants

Performing the tasks above proceeds within the framework of a set of factors which strongly influence the course and shape of the assessment process and the document preparation process as well. These determinants have evolved to meet the overall goal to facilitate better decisionmaking. The second step in document planning is to identify them. Many determinants can be expressed as either legal or policy determinants.

Legal. The EIA process must be designed to comply with statutory obligations. In the United States, the range of pertinent legal requirements includes NEPA, the Council on Environmental Quality (CEQ) or other agency regulations; other legislation such as the Endangered Species Act (16 USC 1531), Wild and Scenic Rivers Act (16 USC 1271, et seq.) or various acts passed to protect cultural resources; executive orders pertaining, for example, to Wetlands Protection (EO 11990), or Floodplain Management (EO 11988); and a host of state or local regulations or laws. An EIA must meet specified coordination, consultation, and permit requirements in complying with these.

Legal requirements strongly influence the shape and content of the assessment process and of the document. Of particular significance is NEPA and the CEQ implementing regulations. These require that an EIA perform two connected levels of analysis. First, it must identify, measure, and assess the environmental changes resulting from the proposal and the alternatives. Then it must compare the alternatives based on that assessment. CEQ regulations also specify certain criteria which an impact analysis must take into account in order to ensure full and fair treatment of impacts and, consequently, better decisions. Prominent analytical objectives are: to characterize a full range of dimensions of predicted impact, including context, intensity, duration, directness, likelihood, and whether impact is cumulative; to be objective, emphasizing objective measurements rather than subjective judgments; and to use a comparative format to allow decisionmakers and the public to differentiate among choices, such as by comparing project alternatives against a consistent set of environmental attributes.

The analytical objectives of the EIA strongly determine the content and format of the document. The document must demonstrate that the analysis fully and fairly represented the "significant environmental impacts" (40 CFR 1502.1) of an action consistent with the scope of the proposal. It must inform both decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts (40 CFR 1502.1). Complexities both of the analysis procedures and oftentimes of the project and its alternatives present a strong challenge for the effective transmission of findings. For many proposals, analysis procedures may need to be complex simply because of the number of environmental attributes, and their interactions, under study. Add to this the fact that a transmission line proposal can often have literally hundreds of possible route combinations and it becomes clear that there are significant obstacles to the goal of clear, concise, and understandable communication of study results.

Legal requirements largely determine the format of the document as well. NEPA implementing rules prescribe such things as page limits, format, and other content stipulations. As examined in greater detail later, these specifications have major ramifications for structuring documents.

Agency policy. Another factor influencing EIA is the need to be consistent with precribed agency policy. For example, agencies commonly have set policies towards project public involvement. If the policy objective is to develop an open and participatory public participation program, planning must reflect this. Agency policy towards the role of the public in the process also influences the type of methods used in identifying measuring and assessing impacts (Lee, 1980).

Another possible policy consideration--one that is pertinent to the utility industry--is the "one-utility concept." This concept specifies that potential power transmission needs be evaluated without regard to individual utility ownerships, so that the most efficient environmental and technical solutions can be developed. Applying this concept helps to avoid the costs and impacts of building duplicate or unneeded facilities in a region. Being consistent with such a policy would likely affect the range of alternative actions identified.

As with the legal determinant, agency policy considerations influence the content of the document. For example, if policy dictates an open and participatory EIA process, then the document must demonstrate how, in fact, the agency has considered and incorporated public concerns in the decisionmaking process. Such information may be reported in an environmental document by: identifying issues jointly with the public; ranking or stratifying importance of issues by using evaluation criteria based on information obtained from the public; and modifying alternatives in response to public input.

Communication

The complement to identifying determinants is to set forth the communication goals and define objectives to communicate study results clearly and understandably. The objectives provide a framework for selecting appropriate methods, for conducting the analysis, and for translating the analysis results into a document. The framework is built by identifying the publics interested in the project, discovering their needs, and strategizing ways the assessment and the document can incorporate and reflect their needs.

The first communication planning objective is to identify interested publics who need to be involved in the EIA process. For any project, there will likely be several interested publics, which together make up the document audience. They may include: project proponents; decisionmakers; interested public officials (representing a constituency or a perceived public interest); individuals, groups, or industry potentially affected by the proposal; environmental interest groups; or agencies with interest in a specific issue (such as cultural resources or endangered/threatened species). Each audience is likely to have different information needs. Some will be looking for technical detail in the document, others for a general picture. Document planners should consciously consider the audiences, their needs, and their varied levels of perception and understanding.

Next, it is possible to define other objectives which will help meet the audience's needs by contributing to the communication strategy. These objectives are strongly correlated to the analysis determinants. It is helpful to view them as guiding the development of analysis methods. Basically, the analysis objectives provide the content or the message and the communication objectives deliver it. Key communication objectives may include the following:

Comprehensibility. The presentation of findings must be comprehensible by the intended audiences. What is more, "the essentials (though not necessarily the details) of the methods should be intelligible and credible to those using its findings" (Lee, 1980). A document needs to be clear, concise, and to the point in detailing impacts (40 CFR 1502.1). It is obvious that developing a simple, orderly, systematic presentation format will facilitate understanding of the study findings. This objective has implications for analysis methods. As discussed earlier, analysis methods and environmental documents are commonly criticized for being too complex. The extent to which assessment methods can be presented in an understandable fashion in the document depends largely on their complexity. The growing importance of the ability of methods to provide appropriate information for both experts and laymen may signal a trend toward methods which are simpler, less quantified, and more descriptive (Bissett, 1980).

Comprehensiveness vs. Selectivity. A document must strike a balance between the tendency to discuss all project impacts (comprehensiveness) and the goal of providing sufficient information on significant impacts to allow differentiation among alternatives (selectivity). CEQ regulations require a focus on significant impacts relevant to decisionmaking and require only brief treatment of less significant issues (40 CFR 1502.1). Specific ways to achieve this are discussed later. Again, these needs have implications for the types of impact identification measures to select (Lee, 1980).

Aggregation. To meet varying audience information needs, it may be desirable to present analysis results on more than a single level of aggregation. For example, decisionmakers may desire a more generalized, composite picture of the significant issues. Technical personnel--not to mention landowners or others directly affected by the alternatives--will require a greater level of detail (disaggregation). It is vital to beware of potential dangers involved with aggregation of impacts. Biased criteria or hidden value judgments may intrude into attempts at aggregation (Hollick, 1981a). Much impact information can be lost in converting to numbers (Bisset, 1980). It is also possible to conceal significant differences by aggregating unlike effects (Hollick, 1981a). Methods of aggregating impacts often rely on subjective weighting schemes which yield composite scores. A particular danger of numerical systems is that they could well "remove decisionmaking from the hands of decisionmakers," and place them in the hands of technical personnel (Bisset, 1980).

Rather than usurp the evaluation function from the public and the decisionmakers, document planners should present impacts and alternatives in such a way that the effects of tradeoffs and combinations can be assessed (Hollick, 1981a). By presenting accurate pictures at the appropriate levels of aggregation and by making clear and useful comparisons, a document can be used to set up the framework for decisionmaking without, in effect, actually making the decisions. Techniques are detailed next.

PHASE II: STRUCTURING THE DOCUMENT

The overall product of Phase I can be seen as the setting forth of goals which a document must meet: an environmental document must present a certain quality of analysis according to a specified format in a way that is consistent with all legal and agency policies. The challenge of Phase II is to structure a document which does this clearly, concisely, understandably, and in a way that promotes good decisionmaking. A major restriction on the effective transmission of findings is the fact that the presentation techniques in a written document are limited.

Presentation Techniques

Presentation techniques refer to both styles and formats. Two styles of presentation are useful in a written document. These are:

- o The expository or declarative style. This simply discloses, describes or reports straight information; it is useful for presenting impacts.
- o The comparative style. It can be used to distinguish among impacts and alternatives; it is useful in "sharply defining issues and providing clear basis for choice" (40 CFR 1502.14).

We have defined six presentation formats which can be used to transmit findings in a written document. These are text, tables, maps, charts, graphs, and pictures. All may be used with either expository or comparative style, although each has certain limitations and advantages in use with one or the other.

A brief characterization of each format will provide a preliminary indication of how each may best be used in a document. Narrative (text) is equally useful as either a reporting or comparing medium. Narrative provides the best opportunity to use clear, simple language understandable by the non-technical person. Narrative sets the stage, rounds out the picture, fleshes out data and statistics (quantitative information). Narrative imparts a "human" descriptive perspective to an analysis. It can be used to tie together disparate pieces of information and to reveal relationships. Spatially descriptive writing can be particularly effective as a good complement to maps. Using narrative in this way to convey a picture of an impact can be difficult but effective.

Narrative can also be used to scale or show gradation in the intensity or severity of effects. This can be done by careful selection of terms. Narrative is also a useful tool to show impacts at varying levels of detail from general to specific. This process is akin to changing lenses on a camera or filtering sand through successively finer screens. The end product--an accurate picture--is enhanced in this way.

Maps show place location, that is, where an action or effect may occur. Maps also show spatial relationships as well as occurrence (presence/absence), and coincidence of resources or impacts. They can be useful in depicting the spatial impacts of alternatives and for spatial comparisons.

Tables, graphs, charts, and matrices can be particularly useful in a comparative format for clearly illuminating differences. They are also concise means of presenting a substantial amount of information. Pie and bar charts in particular are much more efficient than tables of numbers in getting across important information (Hollick, 1979). Examples of these formats are: advantage-disadvantage tables for project alternatives; a ranked comparison of alternatives against evaluation criteria (standards); bar charts and pie charts which characterize relative proportions and place predicted effects in context; cause-effect matrices which delineate interaction between project activities and environmental parameters.

Pictures can be highly descriptive. They are well suited for typifying and generalizing information for presentation. They can also be used for comparison: for example, to simulate a landscape with and without proposed facilities.

Integrated Document Strategies

To satisfy all content requirements within specified formats and length limits, using the finite set of presentation styles and formats, requires a creative strategy for integrating these presentation tools in a complementary fashion. This is the key to Phase II of document planning. That documents continue to fall short of communicating effectively may indicate more a lack of a strategic plan for integrating presentation formats than inadequate methods or faulty conclusions. A strategy is simply the conscious development of a multiple format concept whereby each style and all available formats are used in a mix which takes advantage of the strengths of each in portraying findings.

This approach can yield results more powerful than those using the formats individually with little thought towards strategically linking and mixing them. It can be used to create a cohesive picture of anticipated environmental change; a picture that can be greater than the sum of its parts because the formats reinforce each other. All aspects of a proposal can be illustrated in a tight, cohesive fashion within mandated constraints.

One aspect of integrating style and format in a complementary way that allows much flexibility is to tier the presentation of findings hierarchically. We use this term to describe a layering concept whereby the presentation grades from general to specific coverage in successive levels within the document. It also allows targeting of information for particular audiences.

The idea of apportioning the impact discussion among a document's chapters in presenting varied levels of aggregation provides a good example. One might best start by identifying major format limiting factors such as page length, standard specified format, and prescribed document content (see Fig. 1). Each of these limiting factors forces the document planner to consider creative ways to stay within bounds while conveying illuminating information on potential environmental consequences. For U.S. Federal Agencies limiting factors come largely from CEQ regulations.

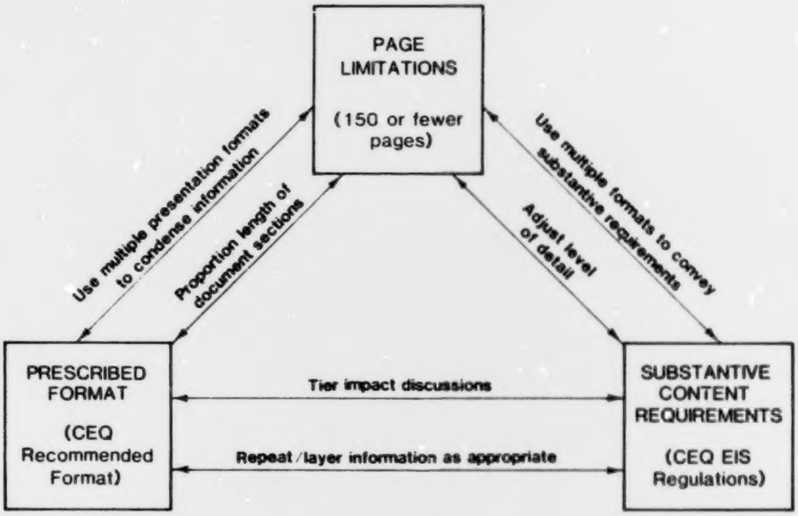
PAGE LIMITATIONS
(150 or fewer pages)
Use multiple presentation formats to condense information
Proportion length of document sections
Use multiple formats to convey substantive requirements
Adjust level of detail
PRESCRIBED FORMAT
(CEQ Recommended Format)
Tier impact discussions
Repeat/layer information as appropriate
SUBSTANTIVE CONTENT REQUIREMENTS
(CEQ EIS Regulations)

Figure 1. Major limiting factors force strategizing possible ways to use available formats to structure a document.

Right away it becomes apparent that the need for a concise document forces use of a clear, simple, systematic format; focuses on need for a selective emphasis on those impacts relevant to decisionmaking; and indicates that use of more than text alone is needed to report them. Other decisions to be examined in this strategizing include level of detail to include in each chapter, number of times to visit a topic in the document, and percent of document to be given over to each chapter. For example, appropriate chapters for impact discussion in an EIS would be the Summary, Environmental Consequences, and Comparison of Alternatives. Factoring in conclusions about analysis results and communication objectives (such as audience types and needs and major public issues) is essential to working through the strategy.

Examining how to set up a hierarchical impact discussion in the Summary, the Comparison of Alternatives, and the Environmental Consequences chapters can reveal appropriate format mixes in achieving desired levels of aggregation within mandated limits. Fig. 2 shows a conceptual framework for this example, progressing from general to specific.

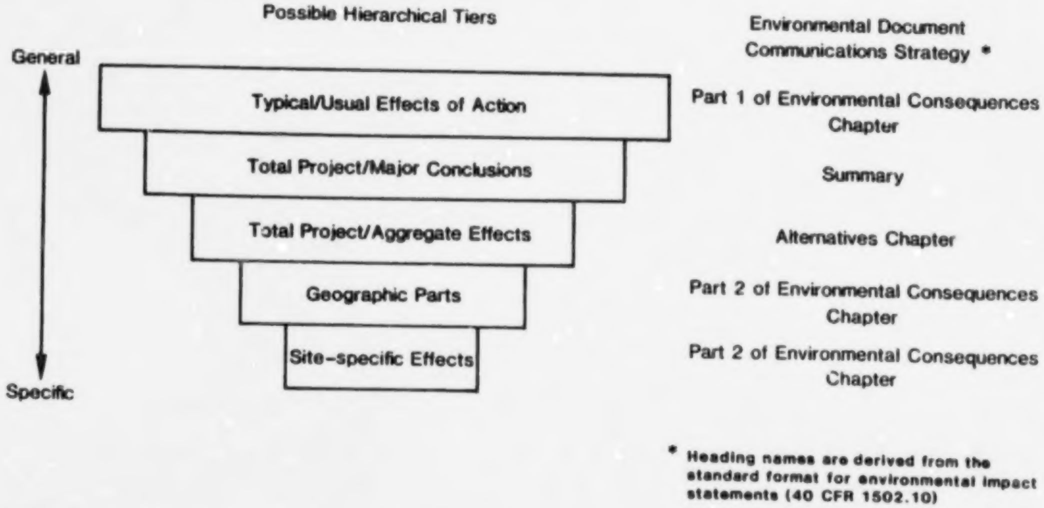
Possible Hierarchical Tiers
Environmental Document Communications Strategy *
General
Typical/Usual Effects of Action
Part 1 of Environmental Consequences Chapter
Total Project/Major Conclusions
Summary
Total Project/Aggregate Effects
Alternatives Chapter
Geographic Parts
Part 2 of Environmental Consequences Chapter
Site-specific Effects
Part 2 of Environmental Consequences Chapter
Specific
* Heading names are derived from the standard format for environmental impact statements (40 CFR 1502.10)

Figure 2. An approach to tiering impact discussions from general to specific level of detail or aggregation in an environmental document.

The Environmental Consequences section can be used to portray both the most general and the most specific pictures of environmental impact. The most generic impact discussion--showing typical/usual effects of an action--can be presented in Part 1 of the chapter. Rather than provide an exhaustive description of all impacts along all alternatives, it may be useful to depict briefly the typical range of impacts expected from activities associated with the type of action proposed. This meets the need to be comprehensive without providing irrelevant, unneeded, or duplicative background. The discussion might be heavy on expository text and tables or matrices relating project activities to affected resources. It would be light on maps--being generic, no locations are involved. Pictures could be used to illustrate typical impacts and to reveal cause/effect relationships.

The Summary section can be used to report impacts in terms of major conclusions for the total project. This is the grossest level of aggregation for the project--it summarizes and defines major issues for decisionmakers and public. It uses mainly expository narrative with reference to important site-specific locations. However, summary tables, statistics, and maps can round out the presentation, while helping meet page length restrictions implicit in a summary discussion.

In the Alternatives chapter, impacts are aggregated for each alternative for the total project. This discussion sharply contrasts alternatives based on significant impacts. Reflecting public concern is a key aspect. It may be accomplished by detailing public input to identification or modification of alternatives (using narrative), identification of issues (using tables, text), or possibly contrasting the proposal and alternatives against criteria derived from the public (using tables, charts, text). This chapter is strongly comparative, favoring a heavy use of tables and charts with different themes, because of the ability of such presentations to highlight comparisons at a glance. Text would be of comparative style and less prominent. It would serve mainly to introduce and tie together the tables and to crystallize and sharpen differences. Maps are useful for spatial orientation in setting up comparisons. Use of tables here may save on text, allowing relatively more text for the Environmental Consequences chapter.

The Environmental Consequences chapter (Part 2) can also contain the least aggregated presentation of impact. This chapter provides the background information for the comparisons of alternatives, the most site-specific level of detail. Depending on the number and complexity of alternatives, it may be desirable to divide this discussion into separate levels to retain clarity of presentation.

Geographic Parts. Breaking a study area into separate geographic sections can provide a framework for presenting disaggregated pieces of information where numerous combinations of alternatives otherwise would obscure presentation of discrete or site-specific findings. Establishing such a framework relies extensively on maps and tables. Text would be highly spatial-descriptive for orientation purposes.

Site-specific. This discussion identifies and evaluates impacts along the alternative routes in detail. Its primary audiences are those locally affected (e.g., landowners) or those needing technical detail. It is the most detailed, descriptive, and disaggregated account of impacts in the document. It is text-intensive--more so than any other part of the document. For this reason, site-specific impact reporting can easily expand out of proportion to its importance. To avoid this and to advance the goal of selectively emphasizing significant impacts, it may be desirable to report only noteworthy impacts and mitigation. (Typical impacts and mitigation measures would have been discussed under the generic section (Part 1) of this chapter.) Maps and tables can be referenced for locational and quantitative information, while also saving space.

Using the multiple-format concept and hierarchical tier approach in structuring a document is an effective strategy for satisfying both analytical and communication objectives. These tools allow presentation of the appropriate level of information to the intended audiences. They allow planning for repetition (at several levels of aggregation) in the document in order to get maximum effect from the repetition inherent in document format specifications while avoiding needless duplication. Finally, they can be used to tie together the disparate spatial, descriptive, and numerical dimensions of impact into a cohesive, effective communication product.

CONCLUSIONS

The main theme of this discussion has been the importance of clear communication in environmental documents. Many studies fall short because findings are buried in jargon, lost in volumes of extraneous information, or too technical to be widely understood. The communication challenge is to find ways to transmit relevant project information in a document that all audiences can readily comprehend and use.

Meeting the challenge is predicated on a flexible planning approach which assumes that knowledge of the document and audience needs should guide the EIA process. The planning approach systematically analyzes all factors which influence or control the assessment and documentation processes, including the styles and formats available for transmitting information. It synthesizes this body of information into a strategy for structuring the document. The multiple format concept and the hierarchical tier approach are useful tools in structuring a document.

Environmental professionals must remember--from the outset of any project--that good decisionmaking based on consideration of environmental values is the goal of performing an environmental impact assessment. Route siting, impact assessment, and indeed the document itself, are but steps towards this ultimate goal. Decisionmaking procedures are being made increasingly accessible to the public. Correspondingly, providing appropriate information to all concerned publics will become more critical. Consciously correlating document needs with analysis steps to produce better, more useful documents is clearly one way to provide appropriate information--one that will enhance good decisions and develop projects that get built.

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THE CORRIDOR CONCEPT

THEORY AND APPLICATION

SESSION 1B PAPER

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1.0 INTRODUCTION

Realizing that few regions are self-sufficient and, therefore, rely on a variety of goods and services to be transferred to and from each region, it is recognized that an efficient transportation system to deliver these goods and services is required. In accord with the requirement that this be an efficient transportation system, the corridor concept has received positive attention in recent years. For the purposes of this paper, the corridor concept may be defined as the placing of transportation facilities within a planned continuous strip of land of varying width and length in such a manner that the use of land for right of way within the corridor is maximized, while at the same time, minimizing, or at least, mitigating against any adverse environmental or social effects on adjacent land uses. This concept implies a comprehensive, multi-disciplinary planning approach.

While this topic is expanded upon in the text of this paper, the primary occupants of such a corridor appropriately include highways, transmission lines, pipelines and railways. Secondary uses which do not interfere with these primary tenants could include hiking trails, picnic areas, recreational facilities, and agricultural pursuits. In order that a workable interface between these primary and secondary uses is accomplished, vigorous accomplished, vigorous inter-disciplinary analysis of pertinent design and location parameters must be included in the planning process. This analysis is highlighted and presented herein.

In light of the cumulative impact of separate individual right of way development and the inherent dangers of unplanned ad hoc development, Mr. Justice Berger, in his report on the Mackenzie Valley Pipeline, states that:

> "There is the oft experienced human tendency to argue that now that some tolerable impact has been permitted, it becomes easier to argue for each successive small increment, each one on its own, perhaps minor, but in the aggregate, inducing serious impact. I (Mr. Berger) have called this destruction by insignificant increment."[1]

This destruction by insignificant increment is exactly what the corridor concept attempts to prevent. If a long range comprehensive planning process instituting the corridor concept is accomplished, it is possible to successfully provide for the energy and service requirements of society, while at the same time, recognizing the land is an environmentally sensitive and finite resource.

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[1] Berger, Thomas R.; The Report of the Mackenzie Valley Pipeline Inquiry; Volume One; 1977, Pg. 82.

2.0 CORRIDOR CONCEPT

Traditionally, rights-of-way for linear facilities have been planned, approved and constructed on a project or case by case basis. Each company generated routing alternatives based upon facility needs, corporate selection criteria and in light of numerous regulatory requirements. An examination of provincial maps of these facilities illustrates the profusion of alignments traversing the provinces in what appears to be an uncoordinated fashion.

In situations of concentrated multiple facility egress, ingress or paralleling alignments, attention is focusing on the use of corridors as a means to reduce land use conflicts.

By way of definition, a corridor is a continuous strip of land connecting two points that contains two or more facilities for the conveyance of people, energy, information or material including facilities such as railways, highways, pipelines, communication circuits and transmission lines.

While examples of corridors exist, they have largely developed without the benefit of firm guidelines, regulations or legislation. For instance, in urban areas, many streets are occupied by water lines, powerlines, and telephone lines, in addition to the paved roadway.

In many cases a highway, transmission line or another linear facility already occupy adjacent rights-of-way and, in essence, these multiple rights-of-way form a corridor. However, each utility is generally planned and operated independently, adjoining chiefly for convenience. Although these incidental corridors demonstrate that various linear facilities can be placed together, they do not demonstrate the intent of the corridor concept.

A planned corridor is a strip of land intentionally set aside for linear rights-of-way and secondary and interim land uses. The corridor is designed and located to meet the needs of industry but also to reduce the impacts of linear facilities on adjacent land uses and the natural environment.

Recently, concern over the potential problems of future linear facilities acquiring access into major urbanized areas has led to the examination of window or penetrator corridors.

These corridors do not preserve the entire right-of-way from source to termination point, but rather are short corridors that start outside the growth area of major urban centres and provide a path through a constraint area to the critical terminal or linkage points.

Penetrator corridors help to ensure that urban development will not inhibit future linear facilities required for economic or urban growth and, conversely, help to reduce the constraints imposed by a multiplicity of linear facilities on the development and planning options in urban growth areas.

2.1 Corridor Aspects

The practical application of the corridor concept, while helping to resolve some concerns, may give rise to others. That is, there are both advantages and disadvantages to applying the corridor concept.

Advantages

The major advantages to the use of corridors appear to be:

Conservation of land

Given that the facilities in question are located above or below the same strip of land, there exists a more concentrated and efficient use of this finite resource. Right-of-way widths can be reduced yet the integrity of the facility is maintained.

Facility Integrity

The designation of a corridor allows for the control of surface uses and linear facility location and construction. The incidence of third party damage would be reduced as contractors, landowners, etc., are aware that a special control area exists and the corridor occupants can require the use of special construction techniques. Furthermore, special conditions can be imposed on the primary and secondary users that afford greater facility security.

Limited Environmental Disturbance

While recognizing that the environmental disturbance within the corridor is high, the corridor concept restricts the disturbance to one area rather than proliferating the landscape with numerous single-use rights-of-way and their cumulative impacts.

Land Use Planning Coordination

The certainty of the future location of linear facilities allows for the integration of these uses into the existing and proposed land use pattern. Secondary and interim use of the surface allows the corridor to complement adjacent land uses.

Further, planning authorities can reduce the external impacts of the future linear facilities by designating appropriate land use districts on the adjacent lands and the using innovative subdivision design.

Disadvantages

While the advantages to the corridor concept are significant, it should not be implied that the concept represents a panacea for all land use problems relating to transportation facilities. In addition to the major requirement that the individual corridor occupants relinquish some of their independence and individuality, the presence of numerous transportation modes within a concentrated strip of land has inherent difficulties. The disadvantages include:

Increased Disaster Potential

Should a natural catastrophy, a subversive action, or major facility failure occur, the potential for multiple facility failure is increased due to proximity.

Environmental Impact Concentrated

Due to the surface disturbances during construction, sensitive environmental systems within a corridor are more likely to be significantly and negatively impacted.

Increased Facility Construction Cost

A corridor route may increase the individual facility length, require special engineering design and mitigative devices, and often requires special construction techniques, the costs to a utility may increase. In addition, the construction and material standards may be higher due to the facility concentration.

Land Acquisition

Although the immediate purchase of the entire corridor would, given increasing land values, probably reduce the overall right-of-way acquisition costs, the amount of front end money is substantial. A major problem with corridors is the question of who should bear these costs.

Land Underutilization

Should linear facilities not require right-of-way in the corridor in the foreseeable future, it may be difficult to justify preserving the land. If, in the future, the corridor were to be abandoned, it could be difficult to convert the narrow strip of land to the same land uses of the neighbouring parcels.

The balance between advantages and disadvantages depends upon site specific factors, however, the corridor concept should be considered in situations involving multiple linear rights-of-way and in areas with severe constraints to linear facilities. Where the corridor concept is considered, a determination of possible alternatives or options for access should be identified, and a comparison of the potential costs, effectiveness and land use impacts of the alternatives undertaken.

2.2 Corridor Components

As stated earlier, corridors are established primarily for the use by the various linear facilities that transport people, energy, information or material. However, the concept has evolved to include secondary and interim uses.

Primary Uses

These are the facilities for which the corridor was created and generally include some combination of highway, railway, gas and oil pipelines, low and high voltage transmission lines and distribution services.

Transmission Lines

A transmission line represents the facility which creates the least physical disturbance during construction, has the fewest engineering constraints and allows for the most successful reclamation practices. The open space provided by the transmission line can be utilized as a recreational asset, and, during the operation phase, the facility is clean, odorless and generally silent. The major impacts of power transmission lines are visual intrusion and electrical interference to communication facilities.

Pipelines

Environmental disturbance during the construction phase is high; however, with proper reclamation, long term impacts can be mitigated.

Engineering constraints are few and facility planning is governed by safety considerations, reliability of service concerns, economics, construction priorities, aesthetic values and environmental factors.

Highways

Given that highway construction causes total environmental disturbance in the local sense, a highway represents the facility which has the greatest physical disturbance during during the construction stage. The final environmental impact is lessened by improved reclamation and landscaping techniques.

Railways

Of the four primary uses itemized, the railway represents the facility which is subject to the least flexible location parameters. If included in a corridor, the alignment of the railway, as the least flexible facility, would dictate the alignment of the corridor itself. With respect to the environmental impact of railway construction, the impact is similar in nature to that caused by highway construction but is of a lower magnitude due to a reduced right-of-way width.

Interim and Secondary Land Uses

Corridors are designated to preserve the long term right-of-way needs of the primary users. However, from the time of designation, the surface of the land is available to both interim and secondary users. These uses ensure that the corridors do not lie vacant and sterilized, but rather support a variety of valuable community and private pursuits.

Secondary Uses

These are uses that are ancillary or complementary to adjacent land uses and are compatible with the primary uses. Secondary use of the corridors gives double value to the lands, as the surface over or under the primary uses (except highways) is utilized. Also, well planned and controlled surface users eliminate costly land management programs such as weed control. Another benefit of secondary use is that it allows the corridors to be integrated into the urban pattern. Generally, these land uses would not require permanent structures, rather they are uses requiring extensive tracks of land. Recreational, agricultural and horticultural pursuits, drainage, storage and parking facilities would be examples. However, site specific acceptable uses would have to be determined based upon an examination of the compatibility with the specific primary users, the existing and proposed adjacent land use, environmental, technical and legal constraints.

Interim Uses

These are temporary, existing or proposed land uses that are either incompatible with proposed primary or adjacent uses. Interim uses cover the transition period from corridor designation through land acquisition and adjacent land development, to full use by the primary uses. In particular, these uses reflect the continuation of existing uses until incompatibilities arise by either the construction of a primary use or the development of adjacent lands.

Buffers

Usually, buffer areas, or open spaces, are provided on the edges of the corridor and in some instances within the corridor proper. Edge buffers provide a greater separation of corridor facilities from adjacent land uses thereby further reducing the likelihood of third party damage. However, these strips also soften the interface between the corridors and adjacent uses, as trees and berms can shield the facilities or blend them into the adjacent land use pattern.

Buffers within a corridor proper are provided on either side of the roadway as a visual and noise attenuation device for both the adjacent land uses and the corridor secondary uses. Further, they can be used as a mitigative technique to reduce technical incompatibilities between primary users or as a safe-fail device.

3.0 GENERAL CORRIDOR LOCATION AND DESIGN PARAMETERS

The planning, design and locating of corridors involves many factors, such as: the facility terminal locations, the need for rights-of-way, the types of transportation modes, environmental and social factors, engineering and design considerations, safety and security concerns, topography, land use plans, economics, and regulations and standards.

The technical design of the corridor must integrate and meet the requirements of all potential users. Each mode of transportation has its own design requirements, technology and new developments to minimize environmental impact. Therefore, when applying the corridor concept all potential users of the corridor and those impacted by the development must have input into the design. This input should come from the engineers, environmentalists, legal representatives, economists, etc., associated with each mode of transport along with input from potential specialized users, adjoining property owners and the general public.

3.1 Component Parameters

A prerequisite for corridor design is an understanding of the specific design and location parameters of each of the potential corridor components.

Although this is not a comprehensive analysis of these parameters, the following summarized points highlight the salient parameters for each primary use.

Transmission Facilities

Power Transmission Lines

From a strictly technical perspective there are few absolute constraints to transmission line routing. The key location parameter of these faciities is the location of the load centers and the generation sites.

Given a homogeneous surface with respect to construction costs, the best route is the shortest, i.e., a straight line. However, given the variations in land and construction costs, and environmental and social concerns, the ideal state is rarely achieved. When designing a route between any two given points the following general parameters assist the selection.

- Where possible, straight line routing should be a priority.
- In order to minimize both environmental impact and potential conflicts between the corridor authority and adjacent landowners, existing rights-of-way should be utilized when possible.
- Rolling or undulating topography should be utilized to screen a powerline from adjacent vistas whenever possible.
- Preliminary route planning should have an appreciation for, and avoid resource areas, such as merchantible or scenic timber areas, mineral deposits, critical wildlife habitat, unique environmental or cultural areas and recreation areas, where possible.
- Sensitive areas such as streams and steep slopes which may be detrimentally effected by construction should be avoided. Should such areas be crossed, proper design and construction techniques should be implemented so as to minimize or at least mitigate the detrimental activities.

Substations

From discussions with industry representatives, it appears that the location of substations is very sensitive to the location of load centers. For substations that step down electric transmission lines to distribution capacities, this is a critical parameter. In terms of efficiency and economy, it is preferable to increase the length of the transmission lines and reduce distribution line length thereby reducing the loss level and line costs. These types of substations require land within or adjacent to the load center. Substations that transform EHV lines, eg., 500 kV to normal bulk distribution capacities (240 kV), are also sensitive to major load centers but from a broader regional perspective, i.e., the substation would tend to locate near the largest load center but also attempt to achieve a centrality to all load centers in the area.

Pipelines

While it is generally recognized that pipelines provide the safest mode of transportation, environmental damage during the construction stage is high and must therefore be accomplished utilizing the highest technical standards to maximize the opportunity for proper restorative measures to be instituted.

These facilities are slightly more sensitive to soil and topographic features and have a greater initial construction impact than powerlines. Again, the ideal routing would be the shortest distance between the source and terminal point but in reality deviations are common.

Factors such as pipeline product, pipeline pressure, topographical and soil conditions, and surveillance and control procedures must be addressed in the initial planning and design stages in order that a full appreciation for the potential pipeline hazards be realized.

The following represents a summary of the design and location parameters to be addressed when locating a pipeline as a separate and individual entity;

- Given that the cost of material in pipeline construction represents a large majority of the overall costs, straight line alignments where possible should represent a primary objective.

- While oil pipelines are more sensitive to grades than gaslines, the general situation is that grades do not represent a major obstacle in pipeline construction.

- Given the environmental impact of constructing a pipeline, the design stage should recognize areas having suitable access roads, camp and storage areas, and those areas which are workable during the winter and wet seasons.

- Environmentally sensitive areas including those locations with a high slide potential due to extreme slopes, saturated sands or silty soils should be avoided. In addition to this, construction difficulties may arise in muskeg areas and areas having a high water table level. These areas should, if possible, be avoided.

- Additionally, areas having a high resource potential or which are environmentally sensitive should, if possible, be avoided. If such avoidance is not possible, proper techniques to ensure adequate mitigation of the detrimental construction effects should be employed.

Highways

Unlike the previous two transportation modes, highway location is subject to fairly rigid parameters. The detailed design of a highway must address the issues of road hierarchy, population density along a proposed route, projected volumes and speed requirements, safety and appropriate sight distances. The general parameters which dictate suitable highway alignments as a separate entity include:

- location of traffic generating centers;
- suitable grade requirements;
- stable, well-drained substructure;
- proximity and availability of construction materials such as borrow and gravel;
- aesthetic resources areas.

While a suitable highway location attempts to address the above items, the alignment planning process must have an appreciation for, and where possible avoid those areas characterized by high water table or muskeg areas, unstable soil conditions due to either steep grades or deep organic soils and major solid rock outcroppings. In addition to such hazard areas, proposed alignments should avoid natural resource areas such as forested areas, aesthetic locations and wildlife habitats.

Railways

During the initial design stages, when planning a railway alignment as a separate mode of transportation, suitable grades usually take precedence over suitable alignments. Given the very nature of a railway, that being that a large amount of goods and services are transported by a relatively small power source, it can be readily appreciated how sensitive a railway is to grades. For example, a load hauled by a single locomotive up a 3% grade will be only one-half that which can be hauled by the same locomotive on a level track. Given this sensitivity, the following represents a summary of the design parameters of railway location:

- straight line alignments along level ground;
- suitable proximity to desired service locations;
- proximity to resource development areas both for goods and service, and construction materials;
- suitable subgrade formations.

As has been the common theme for the preceding three modes, railway planning in turn, must recognize and, where possible, avoid environmentally sensitive areas, unsuitable areas with respect to water table levels and soil conditions or major rock outcroppings. Additionally, natural resource or aesthetic areas should be preserved while, at the same time, being served by the transporation mode.

3.2 Multiple Facility Corridor Concerns

In single mode corridors, incompatibility is not a problem, rather concern is expressed over the construction practices and the potential for third party damage. However, when corridors involving differing modes are created, a number of incompatibilities arise. Most of the problems that result from the close placement of different facilities can be minimized or mitigated by a comprehensive design process which recognizes and assimilates the needs, requirements and responsibilities of each occupant into the overall corridor plan.

Transmission Lines and Pipelines

Combining a pipeline alignment with a power transmission alignment will result in less environmental impact than locating these two facilities as separate entities. However, there are a number of inherent difficultes which must be adequately addressed in the design stage. Power transmission lines and pipelines are guided by the same parameters of straight line alignments, proper soil conditions and avcidance of environmentally sensitive areas. Adequate reclamation techniques for both modes will minimize the long term impact on surrounding land uses. While the two modes have many similar parameters, power transmission lines are subject to less restrictions than pipelines at river crossing locations. This results in a route length increase for the powerline if they are to remain parallel. The major conflict between power transmission lines and pipelines in corridors is an unavoidable result of proximity. Spacing between these two faciities should be in the range of 30 metres due to voltage and resultant current flows which may be induced in a pipeline from adjacent powerlines. These current flows are a result of the phenomenon of conductance, capacitance and induction. Mitigative measures employed to avoid such hazards include carefully planned construction schedules, cathodic protection, and safety procedures. Although a 30 metre separation is required, total corridor width will be smaller than if these facilities located separately, if a larger number of pipelines is involved. This reflects the fact that the right of way for a single line can range from 9 to 30 metres while in a corridor spacing is 15 metres between pipelines. Construction coordination reduces the potential accidents of simultaneous construction.

Transmission Lines and Highways

Again, combining these facilities would reduce the amount of right-of-way thereby lessening the amount of land clearing required due primarily to a reduction in the buffer space between the highway and adjacent uses. However, major concerns would be safety, radio interference and visual impacts. From a safety perspective, the towers must be located at a reasonable distance from the highway to reduce the probability of vehicles colliding with the structures. As the highway has more rigid location parameters, the length of the route will be increased for the powerlines.

Special electrical equipment or design can reduce the communication interference. The use of berms, buffers, landscaping and aesthetic towers can significantly reduce the visual impact. In this instance, the control parameters for corridor design would be those for the highway.

Transmission Lines and Railways

This particular situation is highlighted because there are severe compatibility constraints between these two facilities. Transmission lines create a significant interference problem to the railway communication and signal control system as the rails themselves may be used as the signal conductor. This can be mitigated by the creation of a service road or buffer separation or special equipment on both facilities. As a railroad meanders and the powerline does not have to account for topography to the same extent, this usually leads transmission lines to locate elsewhere due to increased deflections and route length. To remain parallel, the powerline must accept a greatly increased route length.

Pipelines and Highways

Transportation authorities are usually not supportive of locating paraileling pipelines within the highway right-of-way, although it has occurred. The major concern over the close placement of these facilities is that the pipeline may limit the expansion or upgrading potential of the highway and costly relocation or lowering of the pipeline will have to occur. However, from a visual, environmental or technical perspective, there is little impact of the paralleling of these facilities (barring pipe failure). However, care must be taken to protect any surface valve structures from damage through accidents.

Pipeline and Railways

No technical aesthetic or environmental impacts are generated by this particular combination. However, on rough terrain again the pipeline is not as constrainted by grades, and paralleling results in an increase in the number of deflections and route length.

Transmission Lines, Pipelines and Highways

As in the previous circumstance, this combination would result in a reduced environmental impact due to a reduced clearing space and concentrated physical disturbance. Again, the visual impact of the transmission line and possible interference with communication and radio reception may occur but, as noted earlier, both impacts can be reduced by use of buffers and proper engineering design. In this instance, the highway provides an excellent use of the separation distance between the transmission line and the pipelines, thus reducing the potential electrical impact on the pipelines. In this case, the highway alignment would determine the corridor route and the other facilities would have to accept an increase in route length.

Transmission Lines, Pipelines, Highways and Railways

The concerns over this combination are the potential interference of the railroad communication system, and the induction of the pipelines by the transmission lines. However, the placement of the pipeline adjacent to the railroad, next to the highway and then the tranmission line right-of-way can mitigate these concerns. Again, the pipelines, powerlines and the highway would usually deviate from the railroad in rough terrain due to numerous deviations and increased length.

3.3 Summary

Although minor problems arise when combining several linear modes, there are advantages to a corridor system paricularly in constrain areas such as metropolitan areas. Advantages such as reduced construction costs, reduced right-of-way widths, lower maintenance costs, increase in reliability of service, reduced environmental impact, and assured future right-of-way space, are benefits which accrue to both the industry and the general public.

4.0 CORRIDOR ROUTE SELECTION PROCESS

Many articles have been written that discuss processes for route selection and evaluation methods. A review of this literature leads to the conclusion that a universally accepted process or method does not exist and most likely cannot be developed. All processes and methods are limited by the particulars of the proposal, eg., type of facility and site, and more fundamentally, by the subjectivity inherent in the measurement and ranking of values of locational factors, impacts and site resources. However, although there is debate over specific values, there is general agreement that a route selection process should involve the examination of biophysical, socio-economic and engineering factors. The ideal selection process simultaneously attempts to maximize the efficiency and reliability concerns, while attempting to minimize the costs and negative impacts on the environmental factors. This simple statement masks the incredible difficulty of the exercise. These factors are not only of varying complexity and present varying difficulties to the application of comparable measures, but they are also all complexly interrelated. The process for route selection is, in many respects, an Environmental/Social Impact/Cost Benefit Analysis. The proponent's selection process may involve, for instance, the identification of,

- legislated standards of materials.
- technical limitations.
- right-of-way acquisition costs.
- equipment and construction costs.
- significant ecological impacts.
- social impacts.

Some of these factors are relatively easy to identify and measure, eg., land costs, but others are incommensurable or intangibles that defy the standardization of measure. These intangibles are measured differently on personal value scales and, to a certain respect, differently by sectoral interests. For instance, not only can individuals vary on the value they place on these factors but corporation and government agencies can hold varying views. Not only are there a plurality of values for these intangibles, but they are usually strongly held conflicting values, that must be dealt with and a balance reached. Since it is impossible to develop linear facilities without affecting both tangible and intangible factors, trade-offs are always required. Alternatives generated focus on the proponent's objectives, public values and regulatory requirements, but the balance of factors varies, eg., least cost route, least impact route. The decision maker is then presented with the justification of project need, alternatives, knowledge gaps or uncertainties, and the trade-offs involved so that a judicious decision can be rendered.

4.1 Routing Issues

A number of key issues can be identified that frequently arise in the consideration of a linear proposal. These issues have, over time, evolved to the status and form of "constraints" in the eyes of many. Depending upon perspective, an individual or an agency may not support all or any of these "constraint" factors. However, since they do arise often and generate heated debate, it seems easier to attempt to respect them, if possible. For ease of presentation, the constraints have been arbitrarily categorized as either land use, environmental or technical, although it is acknowledged that overlap exists.

Land Use Contraints

Corridor alignments, if possible, should follow existing rights-of-way to further reduce the fragmentation of prime agricultural lands or urban growth areas.

Alignments should not bisect existing or committed planning units to reduce the impact on cohesive neighbourhoods.

Corridors containing, or to contain, hazardous product pipelines should not bisect or lie directly adjacent to residential, institutional or other population concentrations to reduce perceived risk and to lessen potential consequences of failure.

Corridor alignments should attempt to locate in industrial areas or areas of land use or planning unit interface, i.e., between two neighbourhoods or different land use districts, eg., residential - industrial to reduce the impacts on cohesive neighbourhoods.

Alignments should avoid existing and proposed parks as many linear facilities present negative visual impacts.

Alignments should avoid proximity to rural farmsteads or country residential areas to reduce the direct impact on residents.

Alignments should lie adjacent to quarter sections, parcel or field boundaries to lessen the impact on agricultural operations and to avoid the reduction of planning and design options for future development.

Corridor alignments should avoid federal lands and Indian Reserves to reduce the impacts on these areas of extra-provincial concern and to reduce implementation problems.

Environmental Constraints

Alignments must reflect the topography and landscape features so as to reduce the visual intrusion of the facilities.

The number of water or drainage course crossings must be minimal and, those chosen reflect a balance of the optimal geophysical site and the minimal environmental impact.

Alignments should avoid areas of critical aquatic and terrestial habitat for endangered or significant wildlife to preserve these areas and species for the present and future generations.

Alignments should avoid significant historical/cultural resources, ecological or natural areas to preserve these features for the present and future generations.

Alignments should avoid unstable slopes and organic soils to reduce the potential of facility failure.

Alignments should preserve windrows and protective vegetation in agricultural areas to reduce the erosion potential.

Alignments should avoid mineral resource extraction areas to preserve economic development options.

Technical Constraints

Corridors containing, or to contain, electric transmission lines should not interfere with communication, radio, railroad and airport communication systems by preferably avoiding these facilities or, where unavoidable, by the use of mitigative devices.

Corridor alignments should minimize the crossing of existing linear facilities, but where unavoidable crossings arise, increased construction supervision is required.

Corridor alignments should reflect the location parameters of the least flexible component but should also attempt to achieve a viable balance of the requirements of the more flexible components.

Corridor alignments should attempt to reduce the costs imposed due to corridor use by being located where right-of-way needs have been identified and by shortened route lengths and reduced deflections.

Corridor alignments should not significantly reduce the reliability of the components.

All of the above will be of varying importance to different publics and it is recognized that their firm application would preclude development. Further, it is also accepted that these "constraints" must be balanced against economic and efficiency concerns.

4.2 Land Acquisition

It should be noted that without the benefit of regulation, the only mechanism available to preserve future right of way is purchase. Land acquisition has been and will continue to be the major obstacle to corridor development. Principles of equity and fairness, suggest that landowners affected by a corridor designation be compensated by the outright purchase of their holdings.

A utility corridor means that only one acquisition program needs to be carried out instead of a separate program for each project. In times of rapidly escalating land prices, especially near urban centres, the benefit of paying current prices, as opposed to the price in effect when each easement is required, may represent a considerable saving when a number of facilities can be combined into one corridor. In addition, there would be less overall inconvenience and disturbance to the landowners because they would only be required to deal for one right-of-way instead of several over a period of time. Advance knowledge as to the location of all future utilities also removes a variable from the landowner's planned use of his property.

A utility corridor would involve fewer acres of land than would individual rights-of-way for each project in an area.

When a utility corridor has been decided on, the question of who should actually acquire the land must be addressed. From information available, it appears that most concerned parties feel Government should own all the land in the corridor since the corridor is seen to be in the greater public interest.

5.0 OPERATIONALIZING THE CORRIDOR

As earlier discussed, there is presently no legislative mandate in Alberta under which a single corridor authority could effectively administer the corridor concept. In light of this deficiency, the purpose of this section is to present a number of implementation options.

Establishing or implementing land use rights involves interaction between corridor occupants and numerous other agencies such as other corridor occupants, the corridor authority, financial institutions, insurance companies, third party interests, regulatory agencies, municipal jurisdictions and the public at large. Existing instruments in Alberta, whereby the legal interests may be implemented, are through easements, leases, licences, crossing agreements and fee simple title as mentioned above.

One of the major difficulties in administering the corridor concept is the notion of the outright ownership of the lands in question as compared to permanent or temporary rights to use that land. Fee simple ownership of land is essentially a vehicle which grants the greatest interest in the land and usually implies a relatively unrestricted right with respect to the use or occupation of such land. In that it is both impractical and undesirable to grant fee simple ownership to each corridor occupant (be they primary or secondary occupants) it is necessary to develop feasible land use instruments which will grant appropriate land use rights to each of these occupants.

An easement is essentially a right to use or restrict the use of a specific parcel of land (owned by a second party) in a particular manner. While an easement does not represent fee simple ownership, the right to use the parcel in question may be purchased, sold or assigned to a third party. Such easements are ideally suited to the installation and operation of utility corridors in that while the ownership of a corridor could rest with the corridor authority, such easements would provide to each occupant a legal right to their individual alignments within the corridor. Easements are usually granted in perpetuity, however it is possible to implement a procedure which would discharge the easements should the use of the alignment change or if the alignment were to remain unutilized for a specific period of time. Of the instruments noted, easements tend to grant the most permanent right or interest in the land to the easement holder.

Licences, leases and crossing agreements do not create any specific ownership or permanent interest in the land but rather are temporary and contractual in nature. The granting of licences provides the corridor authority with a degree of flexibility in managing those areas of a corridor which are highly congested and easements may be cumbersome.

An alternative to all of the above mechanisms for implementation of the corridor occupancy is the condominium concept. The condominium concept, as applied to a utility corridor, would give each occupant of the corridor a condominium title, as opposed to an easement or other interest. The condominium concept is a different form of owner-occupant relationship by the creation of the "common property interest" and the "occupants private interest". This concept might be applied in conjunction with easements whereby the primary corridor users would receive the condominium titles and the secondary or interim users' interests would be secured by easements, leases or licences. Utilization of the condominium concept in Alberta would require a number of legislative changes.

6.0 CORRIDOR AUTHORITY

Due to the multi-modal nature of the corridor concept and the vested interests of each corridor occupant, there exists a need for a central authority to properly manage the corridor concept. In order that the corridor functions properly, there must be interaction, dependency and responsibility between all corridor occupants themselves and between the occupants and the corridor authority. One purpose of a corridor authority is to provide a forum within which each occupant will have an appreciation and knowledge of all facilities locating within the corridor. This comprehensive information is especially important during the design and construction stages. While the loss of independence inherent to the corridor may be seen by the individual occupants as a detriment, there is compensation provided through the improved economic efficiency in land acquisition, operation and maintenance costs. One of the main impediments to the corridor concept in the past has been the inability of any single user to provide the required leadership to properly administer the corridor as a whole and resolve any conflicts which may occur between the occupants. As mentioned, due to the vested interest of each individual occupant, the optimum management structure for the corridor lies with an independent authority. This authority may possibly be a single government agency, a quasi-government organization or a corporation.

At present, there does not exist an effective legislative framework to establish a corridor authority and any application of the corridor concept in the Alberta context is done pursuant to a multitude of individual Acts. Should the Corridor Authority become a reality, it would be preferable to establish its mandate by specific statute drafted in light of the corridor concept.

Due to the fact that corridors cross activity and resource areas, and regulatory boundaries, the act must have superior standing over all other legislation covering the designated corridors.

That is, although all other legislative or regulatory processes would continue, the act would have first standing.

The legislation should create an administrative authority with the following powers and responsibilities:

- able to recommend to the legislature the location and designation of corridors.
- able to plan and design the designated corridors.
- able to purchase and expropriate corridor lands.
- able to grant an interest to primary, secondary, and interim uses.
- able to develop and enforce development conditions.
- able to provide a forum for dispute resolution both between corridor occupants themselves and with authorities responsible for adjacent lands.
- able to provide a maintenance, inspection and surveillance program for facilities.
- able to prepare necessary bylaws or plans which would specifically regulate the corridor as a separate land use entity.

7.0 ALBERTA CORRIDOR PROGRAM

Since the early 1950's, Alberta Transportation has proposed the construction of Parkway Ring Roads to circle the cities of Edmonton and Calgary. The proposed alignments however, were not protected by a purchased and registered right-of-way, thus as the cities expanded, the road alignment moved. A mechanism to preserve the roadway alignment arose from studies of the corridor concept undertaken in 1973.

Stewart, Weir & Co. was commissioned to prepare a report on the corridor concept and to examine its applicability to the Edmonton - Fort McMurray area. The report comprehensively studied the corridor concept, the need for a corridor and made recommendations regarding likely corridor alignments. Although the Athabasca Tar Sands corridor was only partially declared, it has guided the placement of linear facilities between Edmonton and Fort McMurray.

In this early study the question of an appropriate implementation mechanism was addressed. The study group recommended that a corridor authority be established to designate, operate and administer the corridor. Specifically, two mechanisms were suggested to preserve the corridor alignment from change or intensification of land use: restrictive zoning and provincial government purchase.

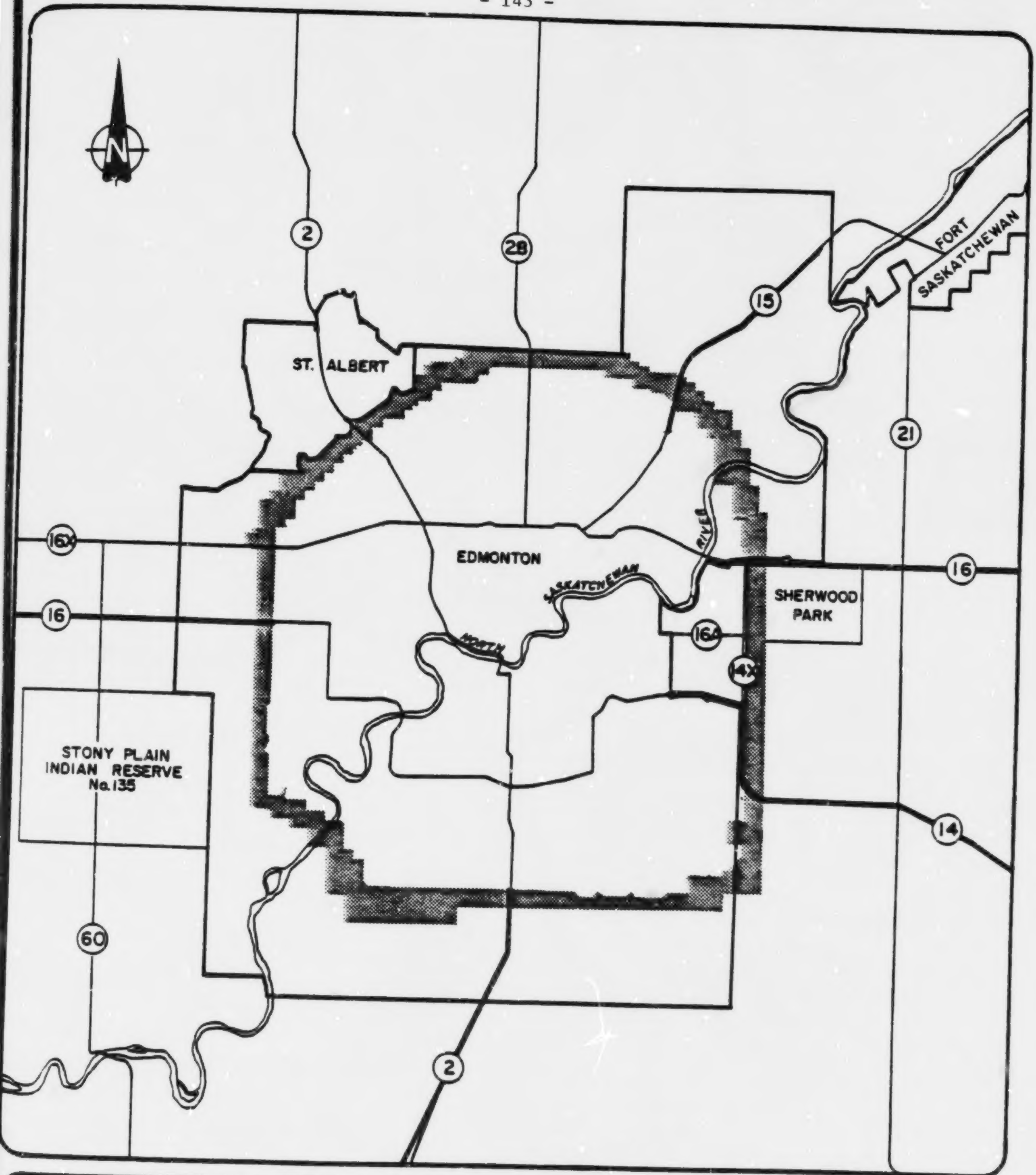
In 1974, the Department of Environment introduced the Restricted Development Areas (RDA) regulations as the enabling legislation for provincial scale restrictive zoning. Also in 1974, the first RDA for corridor purposes was established: a portion of the Edmonton and Sherwood Park West. At the time these RDA's were designated to protect and preserve the Parkway Ring Road alignment. In 1976 the 5 mile Calgary RDA was declared. This larger area was designated for various planning and environmental reasons, only one of which was the preservation of the Calgary Parkway Ring Road. Figures 1 and 2 show the Edmonton and Calgary Transportation and Utility Corridors. Since their designation, the department promoted the use of these areas as multipurpose transportation and utility corridors to preserve not only the roadway alignment but also access for linear facilities into and out of the metropolitan regions for both pipelines and transmission lines. With the policy directions of cabinet, Environment began an intensive and unique planning program.

Representatives from industry, municipal and provincial agencies were appointed to a Technical Committee, to assist department staff in the detailed design of the corridor plans. These plans have provided the foundation for department staff in decisions regarding facility placement, development applications, land acquisition and RDA schedule amendment recommendations.

These corridors have four primary components: transmission lines, oil and gas pipelines, 4 lane divided free flow highway and distribution services (eg., sewer, water, etc.). The arrangement of the components was based upon a number of ideal cross-sections designed for a 1/2 mile corridor width. Figure 3 shows the ideal cross-sections. Modifications to the ideal cross-sections were necessitated by site specific biophysical features, existing land uses and industry projected right-of-way requirements for the areas. In addition, if the roadway alignment meanders, the corridor segments were necessarily shifted from one side to another in some instances. Figures 4 and 5 illustate typical cross-sections for the corridors. To date, a number of linear facilities have located within both corridors.

7.1 Present Administration

Pursuant to Section 16, Department of the Environment Act, Chapter D-19, RSA 1980, the Lieutenant Governor in Council may, by regulation, establish an RDA. The area is established if it is necessary in the public interest to coordinate and regulate the development and use of the Area for the purpose of:


N
2
28
15
21
FORT SASKATCHEWAN
ST. ALBERT
16X
EDMONTON
NORTH SASKATCHEWAN RIVER
16
SHERWOOD PARK
16
16A
14X
STONY PLAIN INDIAN RESERVE No. 135
14
60
2

▨ Edmonton Transportation and Utility Corridor

FIGURE 1

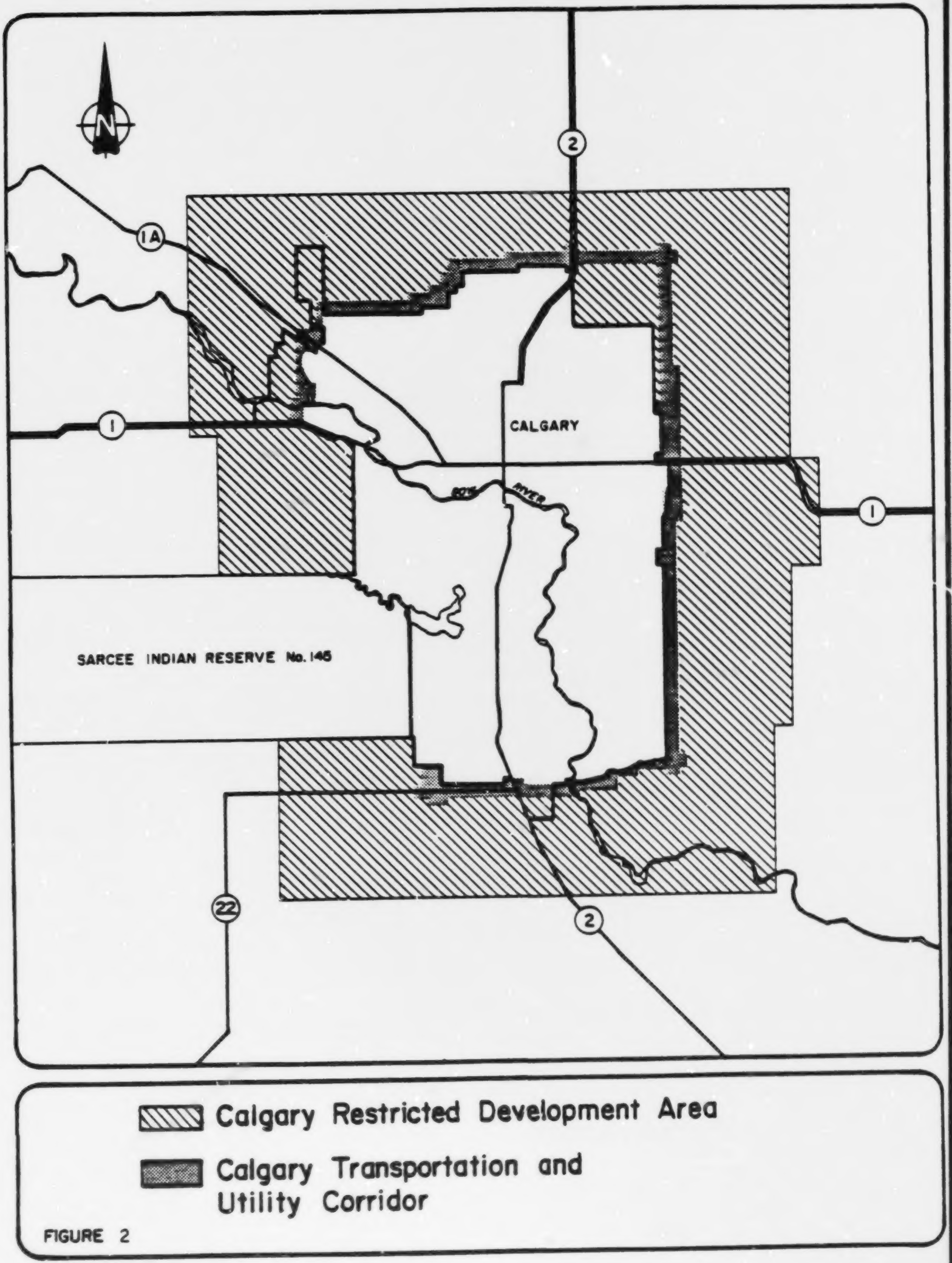
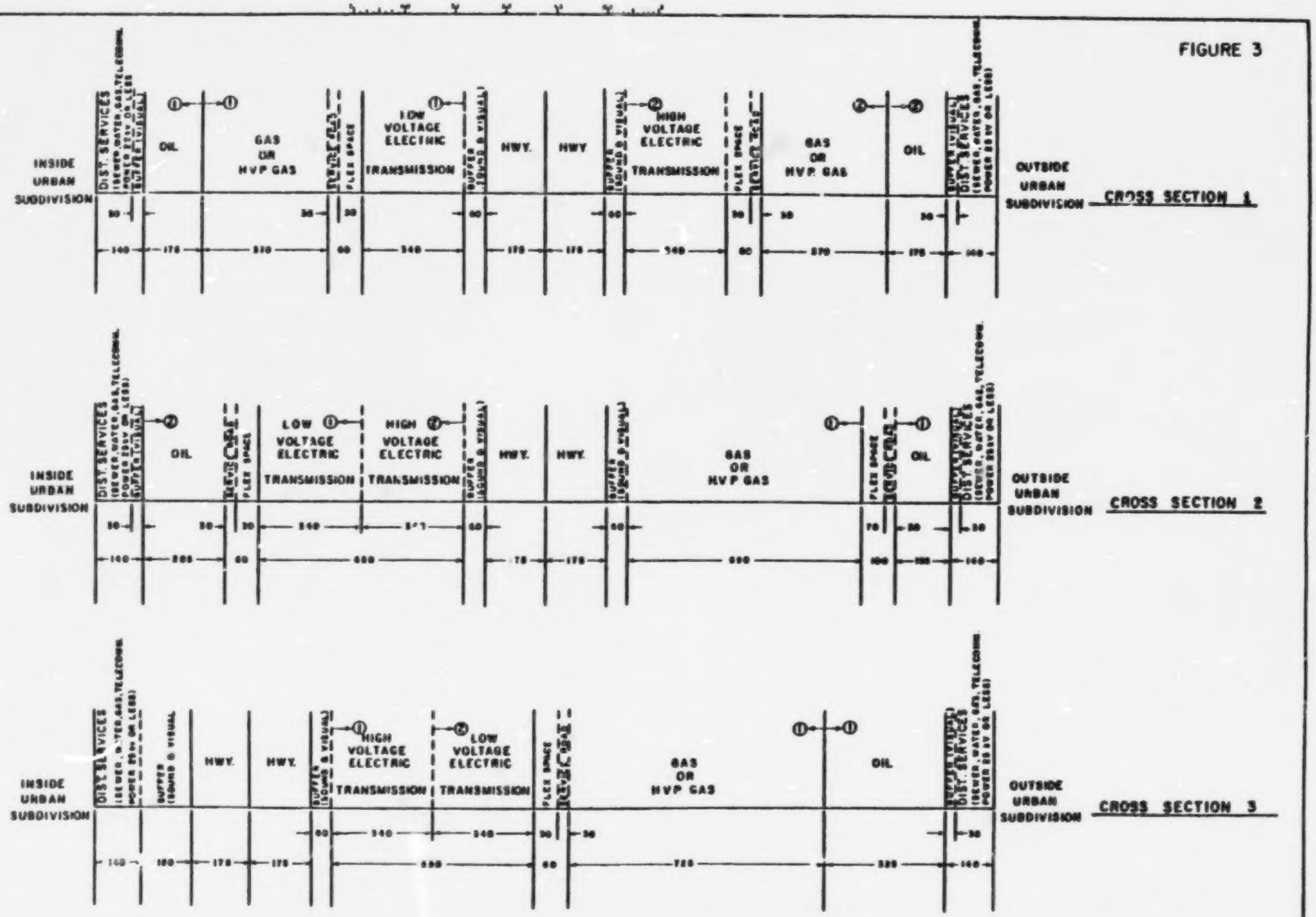

N
2
1A
1
CALGARY
BOW RIVER
1
SARCEE INDIAN RESERVE No. 145
22
2
Calgary Restricted Development Area
Calgary Transportation and Utility Corridor

FIGURE 2

FIGURE 3


INSIDE URBAN SUBDIVISION
DIST. SERVICES (SEWER, WATER, GAS, TELECOMM. POWER 25 kV OR LESS)
BUFFER (VISUAL)
OIL
GAS OR HVP GAS
FLEX SPACE
LOW VOLTAGE ELECTRIC TRANSMISSION
HIGH VOLTAGE ELECTRIC TRANSMISSION
BUFFER (SOUND & VISUAL)
HWY.
HWY.
OUTSIDE URBAN SUBDIVISION
CROSS SECTION 1
CROSS SECTION 2
CROSS SECTION 3

NOTE

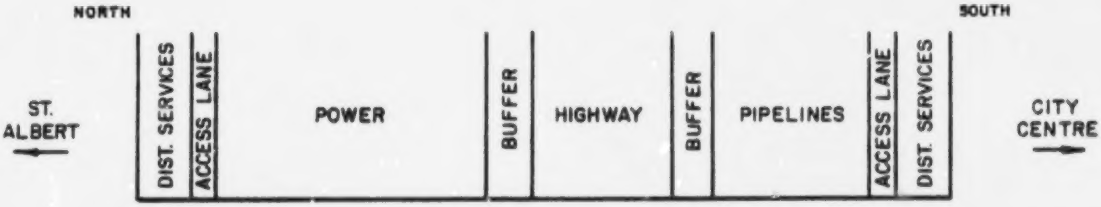
SUGGESTED CONSTRUCTION
SEQUENCE (—①)

LEGEND

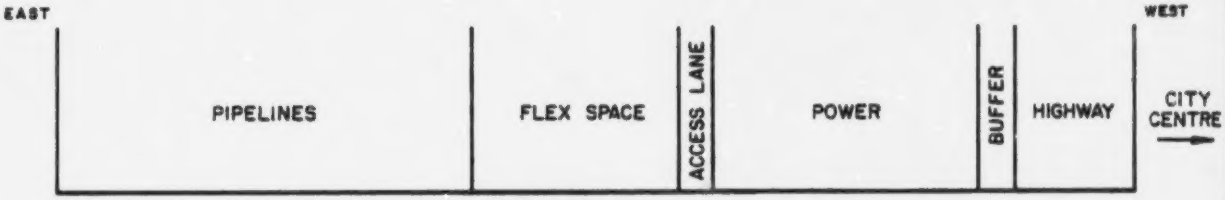
HIGH VOLTAGE - 138 kV AND ABOVE (BASICALLY)
LOW VOLTAGE - ABOVE 25 kV TO 240 kV
DISTRIBUTION - 25 kV AND BELOW
FIG 1
FIG 2
FIG. 3

EDMONTON TRANSPORTATION AND UTILITY CORRIDOR

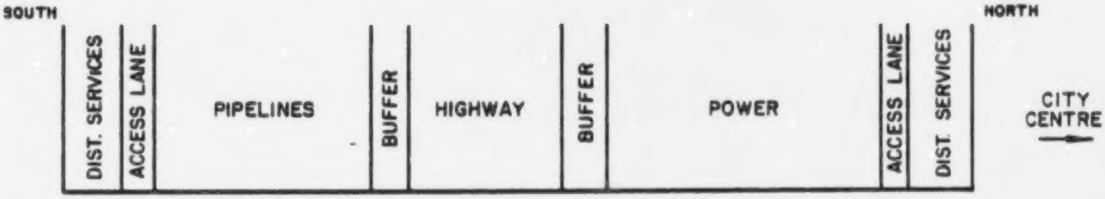
TYPICAL CROSS-SECTIONS


NORTH
SOUTH
ST. ALBERT
DIST. SERVICES
ACCESS LANE
POWER
BUFFER
HIGHWAY
BUFFER
PIPELINES
ACCESS LANE
DIST. SERVICES
CITY CENTRE

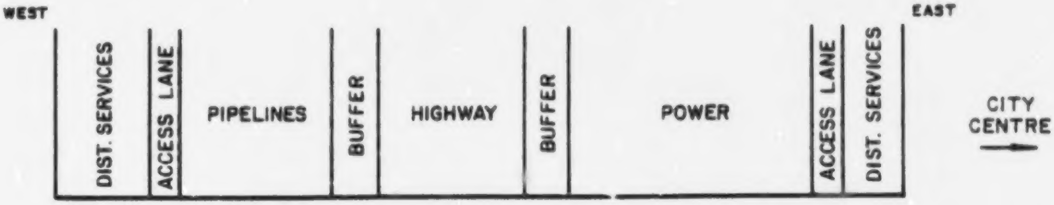
NORTH


EAST
WEST
PIPELINES
FLEX SPACE
ACCESS LANE
POWER
BUFFER
HIGHWAY
CITY CENTRE

EAST

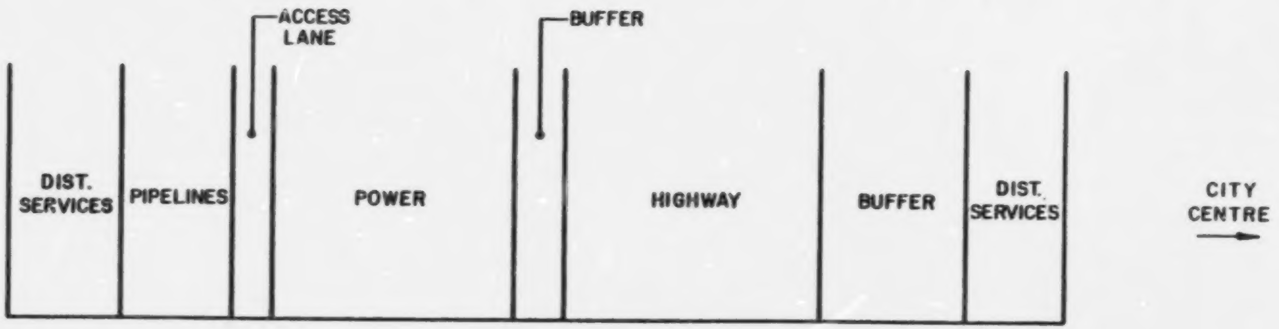

SOUTH
NORTH
DIST. SERVICES
ACCESS LANE
PIPELINES
BUFFER
HIGHWAY
BUFFER
POWER
ACCESS LANE
DIST. SERVICES
CITY CENTRE

SOUTH


WEST
EAST
DIST. SERVICES
ACCESS LANE
PIPELINES
BUFFER
HIGHWAY
BUFFER
POWER
ACCESS LANE
DIST. SERVICES
CITY CENTRE

WEST

FIGURE 4


ACCESS LANE
BUFFER
DIST. SERVICES
PIPELINES
POWER
HIGHWAY
BUFFER
DIST. SERVICES
CITY CENTRE

CALGARY TRANSPORTATION AND UTILITY CORRIDOR

TYPICAL CROSS-SECTION

FIGURE 5

STEWART, WEIR & Co.

- preventing, controlling, alleviating, or stopping the destruction, damage or pollution of any natural resources in or adjacent to the Area, or
- protecting a watershed in or adjacent to the Area, or
- retaining the environment of the Area in a natural state or in a state suitable for recreation or the propagation of plant or animal life, or
- preventing the deterioration of the quality of the environment of the Area by reason of the development of use of land in the Area incompatible with the preservation of that environment, or
- confining to land within the Area,
    - any operation, activity use, development of occupation of land,
        - that adversely affects or is likely to adversely affect the quality or quantity or any natural resource, or
        - that destroys, disturbs, pollutes, alters or makes use of a natural resource or is likely to do so, or
    - any emission, discharge, noise or other environmental pollutant, or the source thereof, whether from any commercial, industrial or other operation, activity, use, development or occupation of land, or
- separating
    - any operation, activity, use, development or occupation of land,
        - that adversely affects or is likely to adversely affect the quality or quantity of any natural resources, or,
        - that destroys, disturbs, pollutes, alters or makes use of a natural resource or is likely to do so, or,
    - any emission, discharge, noise or other environmental pollutant, or the source thereof, whether from any commercial, industrial or other operation, activity, use, development or occupation of lands, from any operation, activity, use, development or occupation of adjacent land.

Section 16.1 (e) and (f) have been interpreted to mean that an RDA can be for the purpose of providing a Transportation and Utility Corridor.

The RDA regulations state that certain activities shall not occur in the area without the written consent of the Minister of Environment. These include the granting by a Minister of the Crown or government official of any estate or interest in Crown land; the exercise of any power under The Municipal Government Act, The Pipeline Act, 1975, The Water Resources Act or any other act to approve of any activity that might cause a surface disturbance of any land in the area; the approving of a subdivision by any government official or agency; the approving, consenting or issuing of any instrument affecting any land located within the area; the continuation, commencement or recommencement of a variety of geophysical operations. No person, without the written consent of the Minister, may continue, commence or recommence any operation or activity that causes, or will likely cause a surface disturbance of land in the area or to construct or erect any buildings on any land in the area. Land uses that existed at the time of RDA designation could continue without obtaining consent. The Ministers consent may be unconditional or subject to any conditions deemed necessary to minimize the adverse effect on the area.

The Minister is given the power to acquire by purchase or expropriation any estate or interest in any land within the area and may order the removal of any buildings, improvements, materials or animals from the area and authorize the payment of compensation. Compensation is not a right solely for declaration of the RDA nor if consent is refused or conditions imposed on a development application. In this regard the RDA is seen to be a form of zoning and in Alberta no one is entitled to compensation solely on the grounds of making a zoning bylaw.

It should be noted that the mere granting of Ministerial consent does not remove the requirement to obtain approval pursuant to any other Act, eg., The Planning Act, nor does it in any way bind or fetter a decision maker or force an approval. Thus, although a proposal cannot proceed without Ministerial Consent, the granting of the consent does not assure it will proceed.

The 13 RDA's in Alberta (3 of which relate to corridors), are administered by the Restricted Land Use Branch, Land Reclamation Division, Environmental Coordination Services, Alberta Environment. The Branch is responsible for the application of regulations which establish each RDA.

The Department is responsible for the implementation of the corridor but this authority for the primary users, specifically pipelines and transmission lines, is somewhat fragmented due to the Energy Resources Conservation Board (ERCB) being the permitting agency for these facilities. Alberta Transportation and the municipalities are primarily responsible for the alignment and design of the Parkway Ring Roads and its eventual construction, while Alberta Public Works Supply and Services is now responsible for land acquisition.

8.0 SUMMARY

The purpose of this paper has been to present the salient features of the Corridor Concept. As presented, the Corridor Concept implies a multi-disciplinary framework which focuses upon a comprehensive planning approach that integrates a variety of primary, secondary and interim uses in an efficient and compatible manner within a designated tract of land. Given the historical inability of a multitude of individual transportation organizations to effectively organize and implement a consolidated administrative structure to manage their joint facilities, the need for a Corridor Authority becomes apparent. The success of such implementation will rely, in part, upon the strength of the enabling legislation establishing the Corridor Authority's mandate.

When planning for the integration of primary uses (pipelines, powerlines, highways and railways) with secondary and interim uses, it is of paramount importance that each occupant be aware of, and incorporate when possible, the design and location parameters of each use, both as individual entities and as they exist in a combined fashion in a corridor. As with the advantages to be had through the operation of a Corridor Authority, there are similar efficiencies realized through a single land acquisition program. While a number of possible compensation scenarios exist, the individual selection of such will, in part, be determined by the specific circumstances surrounding the compensation.

Should such implementation procedures come into force through an appropriate legislative mandate, it will be possible to establish an effective Corridor Authority which can, on both an intra and inter-region scale, ensure that the destruction and waste caused by insignificant increments will be lessened to a significant degree by the application of the Corridor Concept.

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NORTH BAY SHORTCUT PIPELINE ROUTE SELECTION PROCESS

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ABSTRACT

The most challenging aspect of the planning of this new natural gas pipeline was route selection. In choosing the new route, a multi-disciplinary team approach was used, involving consultants with specialized expertise. Factors considered when evaluating alternate routes included economic viability, compatibility with existing and planned developments, protection of natural and cultural resources and impacts on established farming communities and agricultural land. A variety of difficult terrain conditions presented construction constraints, and thus complicated route selection.

Meetings were held with municipalities, utilities and government agencies to gain acceptance in principle of the route. Input into the route selection process by interest groups was gained in large part through landowner meetings organized by the Ontario Federation of Agriculture.

This paper discusses the route selection process and compares it with other qualitative and quantitative methods discussed in the literature concerning route selection and environmental planning.

INTRODUCTION

To meet the increasing demands for natural gas in Quebec and eastern Ontario, TransCanada PipeLines in 1982 constructed a 426 km, 914 mm outer diameter pipeline in new right-of-way from North Bay to Morrisburg, Ontario. This pipeline represented one of the most difficult and complex projects undertaken by TransCanada since the trunkline was built more than 25 years ago.

The construction of the pipeline and subsequent restoration of the land to productive use were accomplished after nearly two years of planning (including project feasibility and route selection studies), environmental assessment, and engineering design work. Liaison with local agricultural organizations, municipalities, provincial and federal agencies and individual landowners was continuous throughout the planning and construction phases.

As the route selection process used on the North Bay Shortcut was very successful, this paper will share some of the insights gained by discussing the routing approach taken, contrasting it with other qualitative and quantitative techniques of route selection.

GOALS AND OBJECTIVES

Three goals were identified as fundamental to the success of the route selection process.

1. The decision-making had to incorporate environmental considerations.

2. The document describing the selection process, alternate routes considered and preferred route had to be explicit, clearly describing the decision making process, assumptions and values, and the trade-offs made during the evaluation.

3. The route selection process had to facilitate effective public and government input into the study.

In order to meet these three goals we adopted an approach that was very straightforward and practical and yet, very effective. We call this the "no-nonsense" or "generic" approach to route selection.

The goal of incorporating environmental considerations into the decision making was accomplished through the formation of a multi-disciplinary team. This is hardly a new idea, but it is one more often advocated than effectively carried out. Throughout the route selection, environmental assessment and pipeline design phases, and during the preparation of detailed recommendations and construction plans, a conscientious effort was made to involve pipeline design engineers, construction experts, right-of-way agents and environmental analysts in the decision making. In this way, a common consensus and commitment to the project was developed.

When it was decided to retain the services of D. H. Duncan & Associates to prepare the environmental assessment report, Mr. Duncan became a part of this project team, attending in-house meetings with the design engineers to discuss the route and virtually all other aspects of the project. Too often when an environmental consultant is retained, he is kept apart from the project team and decision-making, working in isolation and producing an environmental assessment report which satisfies regulatory requirements but which does not figure in the decision making. To be really effective, a consultant participating in an environmental assessment study must be convinced that the assessment is undertaken as an integral component of overall project planning, not just as an after-thought to satisfy legislation.

The four primary objectives in planning the North Bay Shortcut pipeline from the very outset were to:

- transport gas at the lowest cost;
- aid distributors in developing new market areas;
- reinforce supplies to distribution companies;
- minimize environmental and socio-economic disruptions.

Note that our goal of incorporating environmental concerns into the decision making was consistent with one of the four primary objectives of the project.

PHASED APPROACH

The route selection process was conducted in two phases: Phase 1 - establishment of alternate routes and Phase 2 - comparison of feasible alternates and selection of the preferred route or site.

In the first phase, prime alternates were indentified that were viable from the environmental (including socio-economic), construction, engineering, cost and land acquisition perspectives and the major advantages and disadvantages of each were considered. The information for this phase was derived from existing reports and resource inventories, topographic, land use and other maps, government files, interpretation of recent air photos (scale 1:10,000 or 1:5,000), field surveys and preliminary contacts with provincial and local agencies. The data assembled in this manner were then reviewed to identify major constraints. The basic premise underlying the identification of major constraints was that these should be avoided to the extent practical, as they reflected conflicts which would be difficult, if not impossible, to resolve.

Information compiled in the first phase led to the formulation of seven route selection guidelines:

- minimize encroachment on better quality agricultural soils;
- avoid well established, cohesive communities;
- minimize crossing of tile drained land;
- protect natural resources;
- ensure compatibility with existing and projected land uses;
- ensure economic viability of route;
- maximize new markets served.

These constraints and guidelines were then used in conjunction with air photos and topographic maps (scale 1:250,000 and 1:50,000) to evaluate the five route alternates. These alternates were examined in the field using a combination of helicopter surveys, road surveys and on-site field inspections of selected areas. The potential environmental impacts, costs and construction constraints of these five feasible alternates were compared and a preferred route selected.

Detailed investigations were then undertaken only for the preferred route using maps at a scale of 1:10,000 and line location crews in order to design site specific construction recommendations and determine where special environmental mitigative measures would be required.

ELEMENTS OF THE PROCESS

Weighting of Environmental Factors

Unlike a number of techniques which attempt to place a weighting on the key factors or guidelines, we decided in our approach to simply state these factors with no subjective weightings attached. The reason is that it was felt these weightings complicated rather than simplified the analysis. An analyst with a farm background would place a much higher weight on minimizing the crossing of tile drained or good quality agricultural soils, while the biologists might feel that protection of natural resource areas and wildlife habitat was more important, while still others in the Company might feel that cost was the critical concern.

The decision not to weigh the factors was meant to encourage discussion regarding the preferred route and alternates, without spending time on arguments of little practical value such as debating whether a deer yard was more important than a field of Canada Land Inventory Class 2 capability agricultural land.

Compare this to techniques discussed in the literature such as the Optimum Pathway Matrix, where component values are multiplied by a weighting factor to give the relative importance of that particular component. The values are then scaled, in order to give a mean impact index for each alternative. The final equation is:

$$I = (N_i S_x X_i + e_i N_i S_x X_i)$$

$$\text{where } N_i = \frac{\Sigma W_i}{\Sigma W_i \dashrightarrow 56} = \text{scaled weight}$$

$i = 1, 2, \ldots\ldots\ldots, 56$ measurements
S_x = scaling factor for measurement S
S_i = component value
W_i = unscaled weight
e_i = a number drawn from a uniformly random distribution
$-0.50 \leq e \leq +0.50$

Now who understands this kind of weighting system? One of the Company's goals was to use a process which would facilitate effective public and government input into the study. Would this method be particularly meaningful to the Ontario Federation of Agriculture groups which were consulted? Instead, the method of simply stating factors of importance was an excellent starting point to invite comments from interest groups and government agencies.

An overlay technique could have been used to convince those reviewing our proposed route of the limited options in finding a 426 kilometer route from North Bay to Morrisburg. After blocking out the good farmland, woodlots, wildlife areas, areas proposed for future development, and sensitive river crossings there was usually no immediately apparent corridor. In addition, techniques such as the McHarg Method require a determination of factor weighting for different constraints within a map. The reluctance to try to weight different environmental factors has already been discussed. Instead, the approach to route selection was based foremost on a good understanding of the environmental and socio-economic conditions along the study corridor. Once these conditions are ascertained through the liaison program, by ground-truthing and simply walking parts of the corridor, an appreciation can be obtained for the local concerns and sensitivities.

Landowner Input

Acceptance of the preferred route by local government agencies and the affected public is a prerequisite to successful project development. Once everyone on the project team felt comfortable with the preferred North Bay Shortcut route, regional meetings were held. These meetings were a very effective means of involving farm landowners in the project and of identifying their concerns. They were organized through the Ontario Federation of Agriculture (OFA), and were looked upon by TransCanada as information exchanges, not simply as presentations to the public. They were seen as opportunities to obtain site-specific information, and to identify and discuss the key concerns of the landowners affected by our proposals. Not only was information gathered which convinced TransCanada to alter the proposed pipeline route in certain areas, but landowner reaction made it apparent that additional consideration would have to be given to some specific concerns, such as tile drainage repair. In this case, it was determined necessary to have special drainage inspectors present during construction, in addition to the on-site environmental inspectors.

It is dangerous to hold a public meeting without having a good knowledge of the preferred route. This doesn't imply that the environmental consultant has identified the bedrock geology or every tree along the route, but rather that the Company representative has enough knowledge about the study corridor and proposed alternates to answer basic questions from the public.

One reason for the success of the meetings was that key TransCanada people, responsible for various aspects of the job, were present. This included, in most cases, the Managers of our Right-of-Way and Environmental Affairs Departments and the Pipeline Design Project Leader. This reinforced TransCanada's commitment to take the concerns of the local people seriously. The consultant who had prepared the environmental assessment report was also present at the meetings in an advisory role. However, the meetings themselves were chaired by OFA representatives and were held in community centres along the route - Stittsville, Pembroke, Winchester.

Having an interest group act in a co-ordinating role for the public meetings was new for TransCanada. It improved the effectiveness of the community input, created an informal and co-operative atmosphere and contributed to a free exchange of ideas.

Government Input

District, regional and head office staffs of provincial government departments were also contacted in order to identify environmentally sensitive areas and issues. These included the Ministries of Environment, Natural Resources, Agriculture and Food, Culture and Recreation and certain Conservation Authorities. The first contacts were made during the first phase of route selection, when government agencies were consulted to help generate mapping information and to advise about the sensitivity of stream crossings, wildlife areas, forestry management areas, special agricultural uses, etc. This information was used in selecting a preferred route and in preparing the environmental assessment report. Once the route had been selected, a two day meeting and field trip was held to review it with government representatives. When the environmental assessment was filed with the NEB, copies were also provided to these local government offices through the Ontario Pipeline Coordination Committee.

Lastly, every municipality and township affected by the pipeline was contacted for its concerns and comments regarding the route both at the staff and elected representative level.

Other Forms of Public Participation

Compare now the approach to public involvement used on this project to other methods of public participation. Past experience in planning has shown that the more passive forms of public participation, where the public is informed of proposed plans and asked for comments, have placed the public in the role of 'critic' (Lassey, 1977). Rather than involve the public in the planning or route selection process, it asks them only to

FORMS OF PUBLIC PARTICIPATION*

TECHNIQUE	FORM	ADVANTAGES	DISADVANTAGES
1. Opinion surveys.	Letter surveys; Telephone surveys; Door-to-door surveys.	Can survey large cross section of population, quickly, and inexpensively.	Response rate usually very poor; impersonal method, communication is only one-way.
2. Information Presentation (proposals/ plans are presented and public asked to comment)	Exhibits; Films; Information kits; Newsletters; Newspaper reports.	Public is informed; Can reach a large number of people.	Feedback may be limited except in cases of severe opposition; one-way communication only.
3. Information Exchange (provides forum for exchange of views and information).	Public meetings; Open house information centres.	Provides opportunity for feedback; wide participation; two-way communication.	Does not ensure that all views will be heard. Does not allow for ongoing feedback; attracts only the few with sufficient time and interest to come.
4. Citizen involvement appointed representatives work with Company throughout project planning	Working committees; Workshops.	Provides for direct interaction between citizens and Company; assists in gaining support; effective communication; public involvement ongoing.	

*Adapted from Collins, 1978

review and criticize the final product. A resulting lack of support is to be expected. Thus the distinction between involving the public and simply informing them is important.

For this reason the approach taken to public input should be one which involves the public in workshops or working committees. Our approach was similar to that advocated by Francis Bregha in a paper on public participation in which he describes a model of "joint planning", a situation in which officials and citizens assume equal roles in the process of describing needs, aspirations, goals and objectives. This joint planning process need not have decision making powers, but may have problem solving and advisory functions (Bregha, 1973).

The advantage of this method is that it involves the public throughout the planning process and promotes effective two-way communication. Greater understanding may be achieved of the proposed pipeline project, the environmental problems, constraints on the range of solutions, and the positive values of the proposal, which in turn will contribute to public support for the route. The joint planning model fulfils an educational role while it facilitates active communication between the public and decision makers.

Comprehensiveness of Data

A very important feature of the generic approach to route selection lay in determining how much and which environmental data to collect and synthesize in evaluating the routes. It is unreasonable and impractical to assume that all information is required, or even useful; however, an information base of a physical, biophysical and cultural (socio-economic) nature of some degree of specificity is necessary. In making this decision, a judgment was made in determining which factors were worthy of investigation and which were not. The process used in determining where to concentrate our efforts in data collection have been described in the literature by Etzioni as the "mixed scanning model", which combines the "collection, processing and evaluation of information with the process of making choices" (Etzioni, 1968). This is accomplished by:

1) focussing in on specific, detailed information known to be of importance and immediate relevance (high resolution scan: high in detail, low in coverage); and

2) review of information relating to matters that could be significant, followed by a more detailed focus on those items that preliminary observation has suggested are important (low resolution scan: high in coverage, low in detail).

This method directs the environmental assessor to concentrate on those factors which are known to be significant, and then to comprehensively review all other factors and to select those which appear worthy of additional attention based on the goals and objectives. This method combines the incrementalist's and comprehensive planner's approaches by considering all factors to some degree, but also acting on a priority basis starting from the most important. The scanning does not need to be limited to only these two levels; there may be more levels of varying degrees of detail and coverage.

The alternative to collecting only key data is to gather data regarding all aspects of the biophysical and cultural environments. This could create confusion in the inventory and decision making process, as relevant data would be submerged by information of little importance to the undertaking of the analysis at hand. In addition, this method would be extremely costly in terms of staff, time and sampling costs.

But even though this method has been given an official name by Etzioni, we maintain it is really little more than a practical, common sense approach.

SUMMARY

In planning future route or site selection studies the following three goals which were employed in this study, are suggested:

1) Ensure that environmental objectives play a role throughout the decision-making process.

2) Keep the route selection study simple and informative.

3) Seek timely public and government input, as this is essential.

A fourth goal which emerged during the process and which is now felt to be very important, is to be careful not to promise the impossible, and conversely to keep the promises that are made to landowners, public interest groups and governments.

From our experience, complicated mathematical models comparing alternate routes, overlay mapping techniques which use weighting systems, and confusing matrices do not stimulate discussion about the proposed route or project. Knowledge of the study area gained from on-the-ground field work and talking to local government experts and public interest groups to identify key concerns are the prerequisites to a successful routing study. Keep the accompanying environmental study as simple as possible, while providing sufficient information on the key areas of concern and alternate routes to permit decision-making.

Above all, keep the lines of communication between provincial agencies, public interest groups and within your own companies open to permit changes to correspond to additional technical information or changing perceptions of the project. The flexibility of this practical, straightforward or "generic" process allows for innovation and incorporation of any technique appropriate in a given situation. It may therefore be more advantageous to adapt common sense to route selection than try to rigidly follow the guidelines of a complicated technique.

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A HIERARCHICAL APPROACH FOR HIGH VOLTAGE TRANSMISSION LINE LOCATION ANALYSIS

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ABSTRACT

This paper investigates the applicability and potential of the Analytic Hierarchy Process (AHP) for use in high voltage transmission line location analysis. The results of this investigation provide a methodology that utility planners and others may employ when faced with decision making for problems involving multiple objectives that may be ill-defined and subject to uncertainty. The paper demonstrates the use of the AHP technique for the consideration of many parameters of concern that do not always lend themselves to quantification. The authors conclude that the approach should be of interest to those involved in assessing the political, social and environmental aspects of generation and transmission planning by a utility.

ANALYTIC HIERARCHY PROCESS (AHP)

The Analytic Hierarchy Process (AHP) was developed in the early 1970's by Thomas Saaty of the University of Pennsylvania. The following material describing the AHP was derived from his text on the subject &lrbrk.1]. Saaty's approach seems particularly appropriate for problems that involve several objectives, some of which may not be defined clearly such as environmental quality, health, and political influence. AHP was designed to be applicable to such analyses. The ideas related to this topic have gradually evolved through use in a number of applications ranging from:

- Energy allocation
- Investment in technologies under uncertainty
- Designing and test problems for comparing optimization software

The AHP technique operates by using pairwise comparison judgements to consider factors which are not effectively quantified. Factors subject to uncertainty, ill-defined parameters, conflicting objectives and inexactness in measurement may be considered with the judgemental process. It is recognized that judgement can be highly variable and difficult to work with. However one may study the consistency of judgement, and its validity under certain contexts.

The discussion of AHP is initiated with respect to any system of interest. A system of interest may be regarded in terms of:

1. Structure -according to the physical, biological, social, or even psychological arrangement of its parts and according to the flow of material and people which define the relations and dynamics of the structure, and
2. Function -according to what functions the components of the system are meant to serve and what objectives they are intended to fulfill.

A hierarchy is an abstraction of the structure of the system. It is utilized to allow us to study the functional interactions of its components and their impacts on the entire system. This abstraction can take several related forms, all of which essentially descend from an apex (an overall objective), down to sub-objectives, down further to forces, which affect these sub-objectives, down to the people who influence these forces, down to the objectives of the people and then to their policies, still further down to the strategies, and finally, the outcomes which result from these strategies.

Two questions arise in the hierarchical structuring of systems: 1) How do we structure the functions of a system hierarchy? 2) How do we measure the impacts of any element in the hierarchy? Very often the number of entities and their mutual relations increase beyond the ability of the analyst to comprehend distinct pieces of information. In such cases, the larger system is broken up into subsystems, in a manner analogous to the use of subroutines to simplify FORTRAN programming. A hierarchy displays a particular type of system, which is based on the assumption that the entities can be grouped into disjoint sets, with the entities of one group influencing the entities of only one other group, and being influenced by only one other group. The elements in each group (also called level, cluster, stratum) of the hierarchy are assumed to be independent.

There is no set procedure for generating the objectives, criteria, and activities to be included in a hierarchy. These are essentially determined by the way we choose to decompose the complexity of the system of interest. Such a process is interactive, (usually iterative) involving brainstorming, evaluation, debate, as well as legal, political and social considerations. Figure 1 indicates levels for a particular type of hierarchy, but it is really up to the person(s) formulating the hierarchy to become satisfied that the levels relate naturally to one another. If necessary a level can be expanded into several levels or even dropped from the hierarchy.

In the development of a hierarchical theory the impact of a level on an adjacent upper level is evaluated as follows. Use the composition of the relative contributions of the elements in that level with respect to each element of the adjacent level to determine these impacts. This evaluation may be continued upwards through the hierarchy.

HIERARCHY CALCULATIONS AND PROFESSIONAL JUDGEMENT

A technique for determining relatively how much various elements in one level of a hierarchy influence the elements on the next higher level is now presented. By composition we may then compute the relative strengths of the impacts of the elements of the lowest level on the overall objective (highest level).

As an example, let us consider a simplified version of a transmission line location decision. Suppose that there are three alternative routes under consideration and that two attributes are being examined: construction costs and regulatory requirements. The corresponding decision hierarchy could be depicted as in Figure 1.

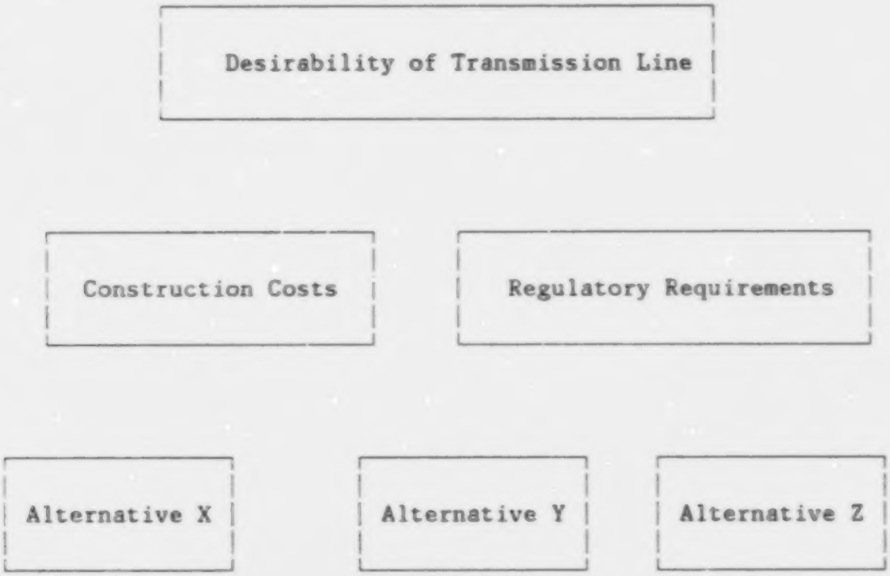
Desirability of Transmission Line
Construction Costs
Regulatory Requirements
Alternative X
Alternative Y
Alternative Z

Figure 1: Transmission Line Decision Hierarchy

Now suppose we wish to compare the transmission line alternatives with respect to the cost attribute. We denote the estimated costs as r^1, r^2 and r^3 for the X, Y and Z respectively. Next we perform pairwise comparisons of the cost of each possible pair of transmission lines and put the results in matrix form as summarized in Figure 2:

$$\begin{array}{cccc} & \underline{X} & \underline{Y} & \underline{Z} \\ \underline{X} & r^1/r^1 & r^1/r^2 & r^1/r^3 \\ \underline{Y} & r^2/r^1 & r^2/r^2 & r^2/r^3 \\ \underline{Z} & r^3/r^1 & r^3/r^2 & r^3/r^3 \end{array} = A$$

Figure 2: Pairwise Comparisons of Three Alternatives

Note that this matrix is a positive reciprocal matrix and that if we multiply this matrix by the transpose of the vector (r^1, r^2, r^3) we obtain the transpose of $(3r^1, 3r^2, 3r^3)$. If we denote the matrix above by A and the rating vector by $\underline{r}$, then the following matrix equation holds:

$$A\underline{r} = 3\underline{r}$$

To obtain the $\underline{r}$ from A we must solve the system of equations $(A-3I)\underline{r} = 0$. In general, for n alternatives this system becomes $(A-nI)\underline{r} = 0$. A vector which satisfies $(A-nI)\underline{r} = 0$ is known as an eigenvector of A, with n its corresponding eigenvalue. Since A is of unit rank (every row is a constant multiple of the first row), all but one of A's eigenvalues are zero. Further, $(A-kI)\underline{r} = 0$ (with k as a constant) has a non-zero solution if and only if k is an eigenvalue of A. Finally, we know that the sum of the eigenvalues of A equals the sum of the diagonal elements of A, in this case n. Therefore our single non-zero eigenvalue is $k=n$ and there is a non-zero solution to general system $(A-kI)\underline{r} = 0$.

It turns out that any column of A is this non-zero solution. These columns differ only by a multiplicative constant and thus represent the same solution. In the AHP it is customary to normalize this solution vector so that it sums to 1. The normalized solution is then called a priority vector. The priority vector, in this case for which exact pairwise comparison is possible, is

$$r_1/(r_1+r_2+r_3),$$
$$r_2/(r_1+r_2+r_3),$$
$$r_3/(r_1+r_2+r_3).$$

This matrix A also has perfect consistency, i.e. the following equation holds for all entries of A:

$$a_{ij}a_{jk} = a_{ik}$$

For a realistic application of AHP (requiring pairwise comparison for factors subject to uncertainty), it is not reasonable to expect every decision maker (DM) to be perfectly consistent; however, most DM's should be somewhat consistent. Since small changes from perfect consistency in A imply small changes in the eigenvalues, we can still solve $(A-kI)\underline{r} = 0$ for $\underline{r}$, except that k is now the maximum eigenvalue of A, a number which is likely to be somewhat larger than the dimensionality of A. In fact, the closer the maximum eigenvalue is to the dimensionality of A, the more consistent A is.

It is possible to process any pairwise, positive reciprocal matrix to retrieve the priority vector (r in the previous example). Saaty, however, recommends that in practice, that DM's should limit their choice of values for entries to the following list: { 1, 2, 3, 4, 5, 6, 7, 8, 9, 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9 }. Saaty believes that this set of choices is optimal both from the point of view of ease of computing the priority vector and also because it provides just the right amount of resolution for distinguishing between two alternatives. Keeping in mind that the DM is comparing two attributes (or alternatives) A and B, with respect to an attribute U, in a higher level, the following meanings for these numbers have been suggested:

1 - A has the same importance as B with respect to U.

3 - A has slightly more importance than B with respect to U.

5 - A has more importance than B with respect to U.

7 - A has considerably more importance than B with respect to U.

9 - A totally dominates B with respect to U.

1/3 - B has slightly more importance than A with respect to U.

1/5 - B has more importance than A with respect to U.

1/7 - B has considerably more importance than A with respect to U.

1/9 - B totally dominates A with respect to U.

The numbers {2, 4, 6, 8, 1/2, 1/4, 1/6, 1/6, 1/8} are used for further refinement and resolution by the DM. By convention, the matrix A is set up so that the numbers refer to how much more or less important the left column entry is than the upper row entry with respect to U. For the transmission line example, if the X is slightly more important than the Y with respect to regulatory requirements, we would place the entry 3 and its reciprocal in the A matrix as shown in Figure 3:

	X	Y	Z
X	1	3	_
Y	1/3	1	_
Z	_	_	1

Figure 3: Partially Completed Rating Comparison Matrix

Suppose we have the following comparisons for the transmission line alternatives:

Table 1: Rating Comparisons

Desirability	
1	5
1/5	1

$\lambda_{max}=2.00$

CI=0.00
CR=0.00

Cost		
1	7	5
1/7	1	5
1/5	1/5	1

$\lambda_{max}=3.44$

CI=0.22
CR=0.38

Regulatory Requirements		
1	3	4
1/3	1	2
1/4	1/2	1

$\lambda_{max}=3.02$

CI=0.01
CR=0.02

Composite priorities (0.70 0.21 0.09)
CRH = 0.31

The third and final activity in the AHP is to combine the priority vectors for each level in the decision hierarchy. Suppose the 2nd level of the hierarchy, containing the attributes (construction costs and regulatory requirements) has a priority vector of (0.83, 0.17) with respect to desirability. The priority vector for transmission lines with respect to the cost attribute is (0.72, 0.20, 0.08) and with respect to regulatory requirements is (0.62, 0.24, 0.14). We wish to combine these priority vectors into a single priority vector on the alternatives with respect to the top level, the desirability of the transmission line. This combination gives a composite priority computed as follows:

X $((0.72)\ 0.83) + ((0.62)\ 0.17) = 0.70$

Y $((0.20)\ 0.83) + ((0.24)\ 0.17) = 0.21$

Z $((0.08)\ 0.83) + ((0.14)\ 0.17) = 0.09$

Alternative transmission line X is consequently this DM's first choice for a residential installation.

In a similar manner, the priority vector on the alternatives with respect to the top level can be computed for any decision hierarchy. This final priority vector represents the DM's scaling of the alternatives, all things considered.

Let λ_{max} be the maximum eigenvalue. The closer λ_{max} is to n (the number of activities in the matrix) the more consistent the result. Deviation from consistency may be represented by

$(\lambda_{max} - n)/(n-1) = CI$ (consistency index)

For the above example the cost matrix had a

$$\lambda_{max} = 3.44 \text{ and } CI = 0.22$$

Random Index (R.I.) is the consistency index for a randomly generated reciprocal matrix from the scale 1 to 9, with reciprocals forced [8].

Saaty gives the average R.I. for order of matrix as follows

1	2	3	4	5	6	7	8	9	10
0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

11	12	13	14	15
1.51	1.48	1.56	1.57	1.59

$$\text{Consistency Ratio (C.R.)} = \frac{\text{C.I.}}{\text{avg R.I.}}$$

Thus, CR = 0.38 for the example transmission line cost matrix.

One may determine the overall consistency ratio of the hierarchy (CRH) in a fashion analagous to the computation of the composite priority vector. This is illustrated for the transmission line example.

First level priority vector: (0.83, 0.17)

First level C.I.: 0.00

First level C.R.: 0.00

Second level vector of C.I.'s: (0.22, 0.01)

Second Level vector of R.I.'s: (0.58, 0.58)

Hence CRH = N/D = 0.31

$$\text{where, } N = 0.00 + (0.83,\ 0.17)\begin{pmatrix}0.22\\0.01\end{pmatrix} = 0.18$$

$$D = 0.00 + (0.83,\ 0.17)\begin{pmatrix}0.58\\0.58\end{pmatrix} = 0.58$$

CONSISTENCY AND AHP

In decision making it is important that consistency of judgement be readily apparent. If a decision process displays obvious inconsistencies then one tends to discard the entire process. On the other hand for problems subject to uncertainty perfect consistency is very hard (if not impossible) to achieve. We are all aware that new experiences and ideas as integrated by the individual may cause previously viewed relationships to appear inconsistent. This should also hold true for judgments subject to uncertainty. That is, a decision maker's judgment may not be totally consistent at any given time due to the evolutionary process of developing experiences and objectives. One last point on the difficulty of achieving perfect consistency is that many situations call for the combined judgment of several individuals. In such cases the collective judgment may lack consistency because of the normal give and take inherent in such a decision making situation. However even in such a situation consistency of judgment is sought, most often in an iterative fashion.

Valid results in the real world decision making process appear to demand that a certain degree of consistency in planning and setting priorities with respect to identified goals be evident. The AHP measures the overall consistency of judgment by means of a consistency ratio (CR). The CR is defined as the ratio of the consistency index (CI) for the quantified judgment comparisons with an average random index (RI) corresponding to the consistency index of randomly generated judgmental values. Previous experience, according to Saaty, has shown that the CR should be ten percent or less.

As an illustration consider the previous simple example involving three transmission line alternatives. Note that the CR was essentially zero for every matrix except the first level 3 matrix. From row one of this matrix we see that alternative 2 is better than alternative 3. However row 2 indicates just the opposite--thus inconsistencies exist for this matrix. Therefore either element (1, 2) or element (2, 3) could be revised to improve consistency. Suppose that after some discussion the (2, 3) element was changed to a 1/3 then the cost matrix becomes CR = 0.06 and CRH = 0.05, which is certainly acceptable.

AHP AND DELPHI TECHNIQUES

There are other techniques (in decision theory) which have been applied to deal with the uncertainty in electric utility planning. For example, the Delphi technique has been applied to power system problems [2]. In the following we briefly compare this technique with respect to the Analytic Hierarchy Process.

The Delphi technique is a well known procedure by which decisions subject to uncertainty, especially those involving factors not directly quantifiable, may be made by "expert judgment". One version of the Delphi technique proceeds by:

1. Selecting a panel of experts to consider a complex question of interest;
2. Preparation of a structured questionnaire by a control group to solicit informed judgment on various aspects of the question faced;
3. Answers are provided independently by the experts;
4. A consensus is established by the control group and feedback is provided to the experts;
5. Adjustments in terms of justifying significant deviations from the norm are requested while at all times preserving anonymity; and finally
6. These adjustments are provided to the entire panel and greater conformity is sought.

One significant difference between the two techniques is that in the Delphi technique, the control group (who administers the survey), not the experts, decide on the variables of interest and also the context of presentation. In the hierarchy approach the experts decide on the variables which have any effect on the judgment to be made. Also in hierarchies the criteria and judgment are established mostly by an open group discussion process.

AHP AND TRANSMISSION LINE LOCATION STUDIES

Some of the uncertainties faced in high voltage transmission line siting include: environmental aspects, aesthetics, availability of financing and regulatory conditions. We have described how AHP can be used for analyzing and prioritizing the effects of uncertainty, and identifying the uncertainty that influence the outcome more than others. This would pinpoint the area where more information is necessary or incremental information would have the highest payback in terms of "better" decisions. In this light we present an example (in Figure 4) showing a much more complex structure of the hierarchy in high voltage transmission line location planning. This only represents a subset of the multitude of factors that might be considered for actual planning. However, the result obtained from applying the AHP to this hierarchical structure is representative of the type of information that will be available from employint this approach.

There are four levels: focus, actors, impacts and alternative routes. Each of these levels is composed of several factors as shown in the boxes. Our aim is to find the relative importance of various actors in influencing the determination of an acceptable power line route (the focus). The functional relationship among various levels is identified through answering the following questions:

- What is the relative importance (influence) of each actor in determining the final acceptable route for the high voltage transmission line?
- To what extent does each impact affect various actors?
- What will be the effect of each route option on the identified impacts?

In a real-life situation these questions can be answered by various groups of people, consistency indices (CI) and consistency ratios cand be checked, modifications to answers can be suggested and finally the composite priorities for the last level can be calculated. These priorities identify the relative importance of each proposed route to the focus (finding an acceptable route). Therefore, for the hierarchy shown, we will have 1 + 8 + 6 = 15 matrices composed of "intensities of importance" ranging from 1 to 9. As explained earlier, reciprocals of these numbers are also possible as matrix elements.

For this illustrative example we have assumed the role of a transmission line location planner and filled out the matrices. The first matrix is shown in Table 2 which is the only matrix in level 2. For example, we say that the relative importance of the utility company (H in Figure 4 and Table 2) is much more (e.g., intensity of '7') than environmentalists (G in Figure 4 and Table 2) in determining the future demand; the relative importance of the company is more than the intervenors but not as strong as before (e.g., intensity of '5') for the same focus. Entries less than one indicate lesser importance. Note that the relative importance with self is always one. Relative weights found from Table 2 are as follows:

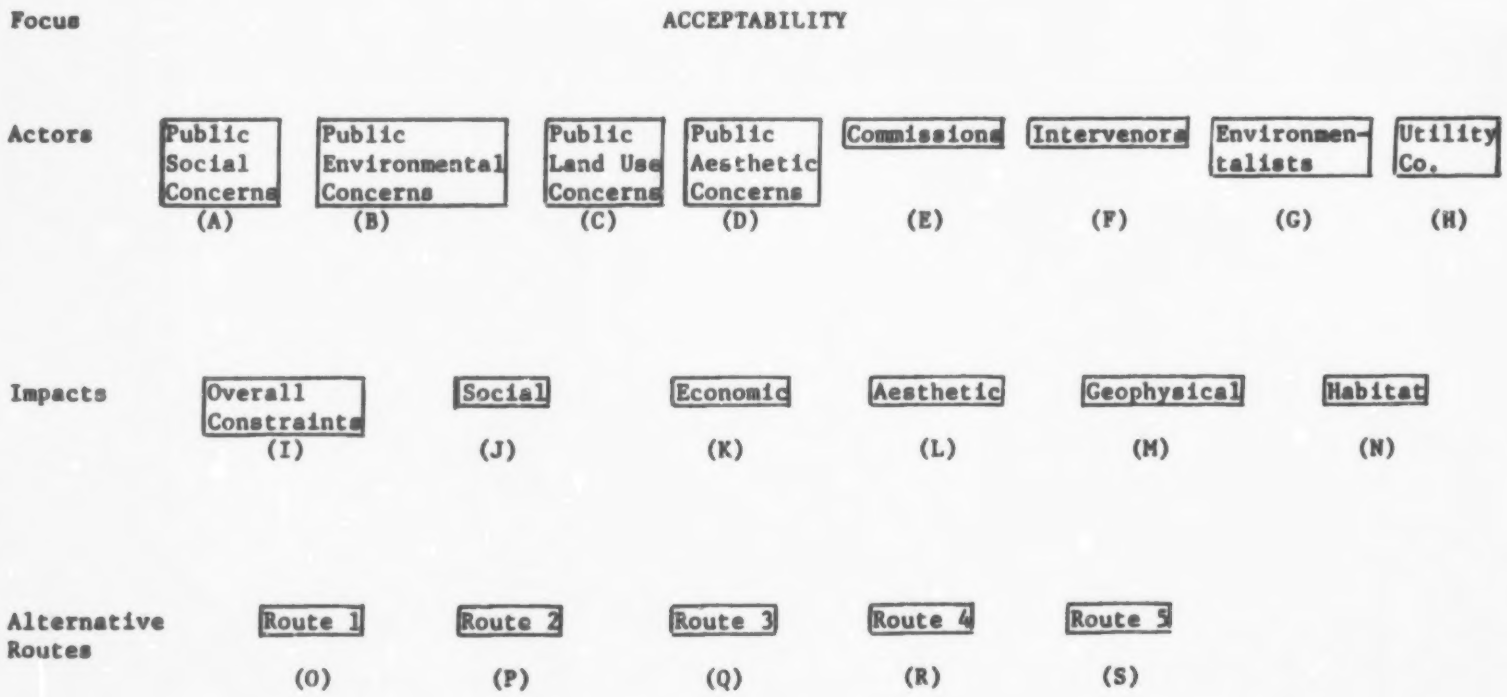
Focus
ACCEPTABILITY
Actors
Public Social Concerns
(A)
Public Environmental Concerns
(B)
Public Land Use Concerns
(C)
Public Aesthetic Concerns
(D)
Commissions
(E)
Intervenors
(F)
Environmentalists
(G)
Utility Co.
(H)
Impacts
Overall Constraints
(I)
Social
(J)
Economic
(K)
Aesthetic
(L)
Geophysical
(M)
Habitat
(N)
Alternative Routes
Route 1
(O)
Route 2
(P)
Route 3
(Q)
Route 4
(R)
Route 5
(S)

Figure 4. Functional Structure of Power Line Location Planning

.122	Public: Social Concerns
.072	Public: Environmental Concerns
.034	Public: Land Use Concerns
.082	Public; Aesthetic Concerns
.252	Regulatory Commissions
.096	Intervenors
.027	Environmentalists
.314	Utility Company

These weights signify that the company has the strongest impact on the acceptable determination, as expected.

TABLE 2: Intensity of Importance (Level 1)

	A	B	C	D	E	F	G	H
A	1	3	3	5	1/3	1/3	5	1/5
B	1/3	1	3	1/3	1/3	3	1	1/7
C	1/3	1/3	1	1/5	1/5	1/3	3	1/7
D	1/5	3	5	1	1/5	1	3	1/5
E	3	3	5	1	1	5	7	1
F	3	1/3	3	1	1/5	1	5	1/5
G	1/5	1	1/3	1/3	1/7	1/5	1	1/7
H	5	7	7	5	1	5	7	1

For level 3 we have eight matrices relating each of the eight actors to all of the six impacts. And for level 4 we have six matrices relating each of the six impacts to all of the five alternative routes. Entries, similar to those in Table 4, are made in each of these fourteen matrices. Relative weights, the consistency index and the consistency ratio are calculated for each matrix. Finally, composite priorities for level 4 are calculated. These are as follows: route one - 0.155, route 2 - 0.230, route three - 0.139, route four - 0.257 and route five - 0.219.

Therefore we can say that, of the five routes considered alternatives two, four and five are the best considered. Whereas alternatives one and three are inferior and may be eliminated from further consideration. More detailed analyses involving further data collection, analysis etc. may be performed on the best alternatives to determine the most acceptable route.

The consistency ratio of the hierarchy (CRH) is found to be 0.136. Saaty [1] suggests that a CRH of above 0.10 signifies that the responses provided by experts may have been inconsistent. Therefore, even though the results obtained for the utility planning example were meaningful, there is room for improvement. The consistency may be improved by returning to the matrices which have a higher than desired λ_{max} and revising the intensities of importance.

CONCLUSIONS

The applicability of the Analytic Hierarchy Process (AHP) for use in high voltage transmission line location utility planning has been investigated and preliminary results look promising. It is demonstrated that AHP can be used to decompose the planning of transmission line siting process into various levels of hierarchy and quantify the impact of various components on the overall decision making process. A more complete development of the methodology can provide the transmission line planner with a decision making tool for problems involving multiple objectives that may be ill-defined and subject to uncertainty.

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ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT OF PEACE RIVER SITES C AND E HYDROELECTRIC ALTERNATIVES

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ABSTRACT

The paper highlights impacts and comparisons for twelve development alternatives involving combinations of hydroelectric dams at four possible sites and with various reservoir elevations as reported by a consulting team for B.C. Hydro in 1976. The basic assessments involved a dam at Site C (1510 FSL) and a low dam at Site E (1355 FSL) with no flooding in B.C. due to a Dunvegan dam in Alberta. Incremental impacts were assessed for alternatives involving no dam at Site E or a high dam at Site E or Dunvegan (1510 FSL). Assessments were made in regard to: Heritage, Climate, River Regime, Geology, Forestry, Wildlife, Fisheries, Agriculture, Recreation, Physical Facilities and Economic and Social Structure. These assessments led to more detailed studies for a development at Site C only which has now been reviewed at public hearings before the B.C. Utilities Commission.

ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT OF PEACE RIVER SITES C AND E HYDROELECTRIC ALTERNATIVES

1.0 DEVELOPMENT ALTERNATIVES

Twelve hydroelectic development alternatives were studied by B.C. Hydro in the 1970's for the lower Peace River. Seven basic alternatives involved a dam at Site C upstream of the Moberly River with a full supply level (FSL) of El. 1510, and at Site E near the B.C./Alberta border with a FSL of El. 1355.

Alternatives 8 to 12 were ways of developing the Peace River jointly with Alberta or by means of a large dam at Site E or at Dunvegan. These arrangements differed significantly from the basic alternatives in that they involved:

- a dam at either Site C or E, not both,
- a small amount of additional flooding between Site E and the B.C./Alberta border,
- flood levels of up to El. 1510, and
- reservoir drawdown.

Table 1 summarizes these alternatives, their FSL's and flooded acreage in B.C.

2.0 IMPACT ASSESSMENT OF BASIC ALTERNATIVES (1-7)

(a) Physical Environment

No gross changes in climate would accompany development of the Sites C and E reservoirs. Local increases in humidity would be expected beginning in September or October when the reservoirs

TABLE 1 - ESTIMATED FLOODED ACREAGES IN B.C. FOR SITES C AND E ALTERNATIVES

Development Alternative	Full Supply Levels* For Dam At			Flooded Acreage In B.C.		
	Site C	Site E	Dunvegan**	Watercourse	Land	Total Area
1	1510***	1355	1250	24,200	18,260	42,460
2	1510	1345	1250	23,880	18,520	42,400
3	1510	1355	1250	24,480	19,770	44,250
4	1510	1352	1250	24,480	19,770	44,250
5	1510	1342	1250	23,880	18,520	42,400
6	1515	1352	1250	24,480	20,000	44,480
7	1515	1342	1250	23,880	18,750	42,630
8	1510***	-	1355	24,590	18,500	43,090
8.1	1510***	-	1325-55			
9	1510	-	1355	24,870	20,010	44,880
9.1	1510	-	1325-55			
10	1510	-	1345	24,270	18,760	43,030
10.1	1510	-	1315-45			
11	-	1510****	1250	26,700	42,140	68,840
12	-	-	1510	26,870	42,430	69,300
12.1	-	-	1480-1510			

* Blank (-) indicates no dam at this site.

** Range of FSL for Dunvegan dam indicates 30 ft. drawdown in March and April; refill in May and June; 30 ft. drawdown in August and September; refill in October and November.

*** Site C dam located upstream of Moberly River for Alternatives 1 and 8, otherwise located downstream of Moberly River.

**** Site E, 1510 located 7,000 ft. downstream of lower FSL dam.

No difference in acreages has been calculated between FSL 1342 and 1345 or 1352 and 1355 since the greatest accuracy attained in elevation measurements and contour mapping has been ±5 ft. Flooded acreage estimates are considered to be within ±5 percent.

would be warmer than the surrounding air. Increases in fog would not be expected until December, by which time crop drying and harvesting is complete.

Up to 75 percent of the existing river banks of the Peace River and tributaries are covered with some form of sloughed material. Variations in geological features and drainage patterns have resulted in landslides; rotational slides in overburden are the most common type of slide.

Stability of a reservoir shoreline would be a combination of:

1. Geological and groundwater conditions;
2. Height and slope of banks;
3. Bedrock/overburden contact elevations;
4. FSL of proposed reservoirs;
5. Reservoir operation;
6. Past performance of shore line.

The future shoreline was classified as to type and relative probability of instability and a "safeline" drawn as a conservative line above which the security of minor facilities, particularly dwellings, could be reasonably assured. Since the potential exists for activating landslides around such a reservoir; the safeline would neet to be used in land use and acquisition planning for the shoreline.

With respect to sedimentation, some of the smaller tributary arms would fill with sediment; for example, the 2-1/2 mile Pine River arm could fill in less than one year.

(b) Forest Resources

An estimated 164,000 cunits of merchantable timber would be flooded by the two reservoirs. Of this quantity about 124,000 cunits of spruce and pine could be salvaged as sawlogs. About 10,000 cunits of poplar and aspen could be used for peeler logs and 30,000 cunits for lumber and wood chips.

Haul costs and the availability of other logs reduce the economic value of these volumes. Using logging guidelines for the Peace River valley, the combined costs of logging, rivertow and truck haul to local mills could exceed the expected log price. The 1975 stumpage value of the 124,000 cunits of merchantable timber at $8/cunit was approximately one million dollars.

(c) Wildlife Resources

Wildlife inventories were conducted to estimate population and habitat characteristics for moose, deer, furbearers, small mammals, ducks, geese and other birds. Moose inhabit the river bottom throughout the year and concentrate in island and flood plain habitats during severe winter conditions. Up to 500 moose could be displaced from these winter habitats by flooding. It is doubtful if the surrounding uplands could provide suitable habitat for these animals due to limitations in browse and greater exposure. Increased use of valley slopes by moose could in turn reduce their carrying capacity for deer.

The impoundments would alter the river habitats used by migrating and breeding waterfowl, shore birds and beavers along 89 miles of the Peace River and 37 miles of tributaries. During flooding some 80 to 100 beaver would be displaced and probably die. A gradual population of the new shore line by beaver would be expected.

Indirect effects on wildlife included: changes in plant communities around the shoreline, creation of a barrier to movement of moose, deer and large carnivores, increased exposure to hunting pressure, increased conflict between wildlife and human activities, and changes in ice-free water available to migrating waterfowl.

(d) Fisheries Resources

Mountain whitefish appeared to be the most abundant sport fish in the Site C and E study area. In decreasing order of abundance, Arctic grayling, rainbow trout, yellow walleye, northern pike, Dolly Varden char, and goldeye were the other sport fish present. Longnose suckers and large-scale suckers are the most abundant non-game fish.

The reservoirs would likely follow the pattern for new reservoirs of an initial large increase in productivity due to an increase in nutrients from flooded vegetation and soils, followed by a sharp decline in productivity as nutrient levels decline. However, the long term productivity would probably level off at about half of the peak conditions.

Mountain whitefish are expected to remain as the most abundan~~c~~t sport fish species, and the populations of most other sport species (with the exception of goldeye) would probably increase in the reservoirs.

The most adverse impact on fisheries would be the flooding of spawning and rearing habitat. Alternative 1 (Site C, 1510 dam upstream of the Moberly River plus a Site E, 1355 dam operated as run-of-the-river) would have the lowest adverse fisheries impacts since it would flood a minimum of tributary streams, provide an opportunity for the development of two tailrace fisheries, and could involve the development of artificial spawning areas at the base of these dams.

(e) Agriculture

Agriculture in the lower Peace River valley was grouped into five production options to which the land and climate are suited:

1. Specialized market vegetables such as cucumbers, beans and sweet corn;
2. Other commercial vegetables such as cabbage, rutabagas and potatoes;
3. Alfalfa seed;
4. Grains such as barley; and
5. Improved pasture.

The surrounding plateaus and uncultivated land on upland terraces are suited to open grazing; some cattle feeding and calving is carried out in the valley.

Total arable acreage in the lower Peace River valley (plus tributaries to El. 1510) is estimated at 38,330 acres all of which is within the B.C. Agricultural Land Reserve. Alternative 1 would flood approximately 27 percent or 10,500 acres of this land. This flooding would also disrupt numerous farmsteads and farm units by forcing relocation of dwellings and changes in agricultural operations.

Land within the lower Peace River valley is unique in the Northeast Region in that it combines high soil and climate capabilities. Some 26,000 acres have CLI Class 1 or 2 soil and climate ratings. Alternative 1 would flood about 4,000 acres of land that has these high capability ratings. The inventory indicated that only 4,880 acres of island and lowest alluvial terraces were suitable for specialized vegetable production and some 4,400 acres or 92 percent of this land would be flooded by Alternative 1.

The nearly complete loss of land suitable for market gardens was the most significant outcome of the agriculturual impact assessment. Production of other vegetables could expand to meet future markets but specialized vegetable production would be curtailed by flooding.

Market projections and production options indicated that some 6,830 acres of potentially productive land would be flooded. If this land was all brought into production in the future at its highest and best use the present value of lost agricultural revenues would amount to from 12 million to 28 million in 1975 dollars.

(f) Recreation

Recreational resource inventories and projections were based on a summarization of the CLI recreation capabilities rating for upland and shoreland units in the valley. Nearly 42,500 acres of existing land and watercourse would be covered by the two reservoirs. This would increase the total water surface by some 18,500 acres and flood over 5,000 acres of islands.

Recreational use of the river is light and there are relatively few points of public access to the water. The visual quality of the valley is high, however, by comparison to the level plateaus that surround it. The islands are used by river boaters for campsites, hiking and picnicking. This type of use is expected to increase gradually with increases in local population and tourism.

Although the land flooded would contain valuable shoreland units, for the most part, these would also be present around the reservoir shoreline. In general the reservoirs would probably have a lower recreational quality than the present river, and would not rate highly as recreational lakes in the region or province. The recreational potential of the reservoirs could be enhanced, however, by providing access and special shoreline treatments. With proper management, the reservoirs could provide a broader range of recreational activities to boaters and fishermen than the river does at present.

(g) Archaeology and History

Historical records from the early 1800's give a sporadic account of the social organization, housing, food, tools, travel and burial practices of the three Indian groups that occupied the Peace River District, i.e. the Cree, Beaver and Sekani. The first Euro-Canadians to reach this area from the east were Alexander Mackenzie, John Finlay, and Simon Fraser. Forts were built as outposts of the Northwest and Hudson's Bay Companies and as fur trading centres.

Archaeological and historical surveys located numerous early fur trade posts and historic buildings and structures within the valley. In some cases these sites are mixed with aboriginal materials which link them with the prehistory of the area. The vast majority of archaeological sites were surface finds of aboriginal lithic materials. Some 235 surface sites were mapped. Display 9 pictures an historic building and projectile points from the surveys.

The potential for loss of archaeological resources due to flooding and surface disturbance increases going eastward. Approximately 20 percent of all sites inventoried in 1974 would be directly affected. Mitigation would involve excavation at historic fur trade posts. Reservoir clearing would need to be scheduled to allow on-going archaeological investigations if salvage is to be possible.

(h) Physical Facilities

The 1975 surveys identified numerous minor physical facilities and several major facilities that would be flooded or affected including:

- 11 Secondary Roads
- 40 Access Roads
- 10 Minor Power Transmission Lines
- 25 Farmsteads
- 93 Rural Dwellings
- 13 Active Gravel Pits
- 8 Seasonal Dwellings
- 130 Granaries and Other Buildings

Flooding, impeded drainage or foundation problems would require a range of remedial actions, from replacement or relocation to alterations and maintenance operations. Financial compensation would need to be considered in the case of farm and rural dwellings and associated separate buildings.

Major physical facilities requiring relocation or reconstruction included: 5 highway bridges and approach fills, 12 miles of highway, various foundations and petroleum facilities. The estimated 1975 cost of this work would amount to about 30 million dollars of which 21 million would be spent in the Site C reservoir area.

(i) Economics

Short-term economic impacts would coincide with the projects' construction phase and long-term effects with the operational phase. Local population and the level of employment and income would all increase significantly during the construction period. The demand for housing and municipal services would increase as well, particularly in the communities of Fort St. John and Dawson Creek.

Population effects during the construction and operational phases were estimated as follows:

1. At peak in-migration for construction of Site C 1510, 3870 additional people could move into the region, largely in the Fort St. John area.
2. In-migration during the peak year of construction on Site E 1355 was estimated at 3250 with the majority residing in the Dawson Creek area.
3. The operational phase would account for a long-term regional population increase of approximately 180, distributed between Fort St. John and Dawson Creek.

The construction phase would have a significant impact upon the level of employment in the region:

1. Construction manpower requirements for Site C, 1510 and Site E, 1355 were estimated at 8230 and 7350 man-years respectively.
2. Participation by regional residents in construction of Site C, 1510 was estimated at 1975 man-years; for Site E, 1355, 2205 man-years.
3. Approximately 450 local residents could be employed directly on construction during periods of peak activity.

4. An estimated 70 additional jobs could be created in regional wholesaling and food processing sectors selling goods and services directly to the projects.

5. The short-term increase in basic employment could generate approximately 500 additional non-basic jobs in local trade and service sectors during periods of peak construction activity.

6. Operation of Sites C and E dams could increase basic employment in the region by an estimated 50 jobs; through the employment multiplier non-basic employment would increase by 70 jobs.

The projected additions to regional income resulting from the project were estimated in 1975 as follows:

1. Total payroll during construction of both projects would be in the order of $318,350,000 of which $180,540,000 could accrue to residents of the region.

2. Estimated net income to be earned by residents during construction could total $126,380,000.

3. $184,430,000 of indirect income could be created in the region during construction.

4. The average income of employed persons in the region would increase by approximately $3,300 per annum during construction.

5. Operation of Site C and E dams would contribute $1,200,000 of direct and indirect income to the regional economy annually.

(j) Social Structure

Valley settlements in the study area include Lynx Creek, Peace Valley Ranch, Taylor, South Taylor and scattered farmsteads and rural residences along the Peace River. Some settlements are based on farming and rural lifestyles established in the early 1900's, others are relatively new farms and residences that are a part of a gradual increase in population and development in the lower Peace River valley. The most serious long-term negative social effects of the dam would be the flooding of valley property and consequent relocation of a number of households.

A benefit to local people living on both sides of the Peace River near the Alberta border would be the use of a dam near Clayhurst (Site E) as a river crossing.

In addition to these long-term, direct social effects, there would be short-term impacts on the social service systems of Dawson Creek and Fort St. John during the construction phase of the projects. These effects are related to the estimated population influx including a maximum of 730 new families into the Fort St. John area and 615 families to the Dawson Creek area. Increased demands would be made on the social services of both communities. Expansion of educational, medical, law enforcement and recreational services would be required.

Negative social impacts have to be weighed against benefits associated with anticipated employment of local residents. The social costs of unemployment are well-enough known to realize that any substantial reduction in unemployment of local residents would be considered a major social benefit. It was estimated there would be a maximum of 450 local people working on the projects for a period of approximately eight years.

(k) Impact Matrix for Alternative 1

An impact matrix was prepared as a summarization of the impacts for Alternative 1. The matrix serves as an index to the studies and provides a graphic display of the types of environmental and socio-economic factors that would be affected by the various development components.

3.0 INCREMENTAL IMPACTS OF OTHER ALTERNATIVES

(a) Lack of Socio-Economic Benefits

The same people who would experience losses due to a projects rarely find their way into high paying construction jobs. Nevertheless, there is some consolation, if not compensation, on a regional basis in the fact that others who live in or come to a region gain employment from construction of a dam which causes losses. However, if a dam was built in Alberta and provided little if any employment benefits in the vicinity of the reservoir in B.C., losses in the Peace region would become out of balance with possible benefits. Since power would be transmitted out of the Peace region, there would be very few regional benefits to offset flooding losses apart from employment. Alternatives 12 and 12.1 involve flooding impacts of sufficient magnitude to almost rule out equitable socio-economic compensation when direct employment benefits cannot be included.

(b) Increased Flooding Impacts

Alternatives 8 to 10 would flood an additional 390 acres of watercourse and 240 acres of land in B.C. between Site E and the border. This incremental impact is small and would not in itself be considered a significant disadvantage to a Dinvegan dam at El. 1335.

By contrast, Alternatives 11 and 12 flood an additional 2,700 acres of watercourse and 24,000 acres of land in B.C. This large increase in flooding would have sufficiently adverse impacts upon natural and human resources in the downstream portion of the lower Peace River so as to place these two alternatives in a completely different category from all others. Sectors in which impacts would be substantial are Agriculture, Physical Facilities and Social Structure. It is reasonable to expect that commercial vegetable production in the Peace River valley would be almost totally precluded by such a development. Additional families would be forced to move. An additional $45 million would need to be spent on relocation and reconstruction of transportation facilities and some $20 million could be required to maintain operation of the petroleum facilities at Taylor.

Direct losses would also occur in Physical Resource, Forestry, Fishery, Wildlife and Archaeology sectors for Alternatives 11 and 12. There would be significantly more shoreline stability problems. An additional 112,000 cunits of merchantable timber would be flooded. An additional 42 miles of downstream tributaries would be flooded thereby reducing their potential for spawning and rearing of stream spawning species. However, sufficient recruitment and littoral feeding could provide a reasonable sport fishery in the Site E, 1510 reservoir. Nearly 24,000 additional acres of wildlife habitat would be flooded with corresponding reductions in ungulate and terrestrial furbearer populations.

The 1510 FSL would flood or severely affect about half of the known archaeological sites in the lower Peace River valley. Fort sites near the Beatton and Moberly Rivers would be flooded and require extensive investigations. Eight to ten years of investigations and excavation would be required to salvage this material.

(c) Drawdown Effects

For certain Dunvegan alternatives, water levels would be continually changing from March through November which would have significant adverse impacts on recreation and visual qualities and could be detrimental to fish and wildlife habitats. The operation of foreshore improvements such as wharves, jetties, marinas, and boat launches would be difficult. In areas where mud and fine sediment were exposed the utility of the shore line for recreation would be greatly reduced. These same shallow (littoral) zones would lose much of their benthic productivity and usefulness to fish.

(d) Impact Matrix for Alternative 11

An impact matrix for Alternative 11 was prepared as a summary and index to impacts, Ratings and notes in this matrix can be compared with those in for the basic alternatives for a comparison between Alternatives 1 and 11.

SESSION I C - MARINE ROUTING

SUB-SEA PIPELINE ROUTING METHODOLOGY FOR REDUCING IMPACTS ON ENVIRONMENTALLY SENSITIVE AREAS IN THE COASTAL ZONE

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INTRODUCTION

There is evidence that transportation of oil and gas by pipeline poses fewer risks to the environment than does transport by surface vessels. Significant environmental problems associated with surface transportation include large scale oil spills resulting from tanker accidents, such as the Argo Merchant spill of 1976 and, the Amoco Cadiz accident in 1978. Chronic spillage related to off- and on-loading transfers, tank washings, and ballast-bilge water discharge is also a problem associated with surface vessel transport. In addition, the sewage and domestic waste generated by tanker operations can have a considerable effect on water quality, especially in habors and bays. Primarily for these reasons, the use of pipelines to transport oil and gas from the outer continental shelf to coastal areas has been encouraged by the governments of several countries. The United States government has encouraged the pipeline mode of transport, as opposed to other alternatives, principally in support of environmental concerns. This does not imply that there are no adverse environmental impacts associated with pipelines. Rather it is important to recognize that generally pipelines pose fewer risks of oil spillage than alternate modes of transport.

The decision to use pipelines and where to locate them is of concern to both public and private interests. An optimal decision is one which will satisfy both groups. However, the criteria by which issues are evaluated are necessarily different. The key, therefore, to achieving a satisfactory decision is to explicitly define the public and private concerns at the outset, then strive for the resolution of conflicts.

Three major factors affect the ultimate siting of pipelines. First, the origin of the line, that is, where oil or gas is discovered; second, the location of onshore facilities for distribution or processing; and third, the location or placement of the pipeline between the origin and destination--the pipeline corridor.

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This paper describes a method for identifying general areas which might be suitable for the placement of pipelines from offshore oil and gas fields to coastal landfalls. These areas are referred to as pipeline corridors which are defined as imaginary lanes of varying dimensions considered during the planning process as an approximate route for pipeline passage. The siting process is an industrial/environmental suitability analysis based on technical considerations for balancing public and private interests. It does not address political, legal, or institutional constraints; socio-economic factors; or site-specific engineering conditions.

THE ROUTING METHODOLOGY: AN INTEGRAL PART OF THE PLANNING PROCESS

Pipeline corridors or routes are usually determined by petroleum and pipeline companies. The primary industrial consideration in the route selection process is cost--the shortest and least complicated route, in terms of construction requirements, is the best route. In some cases, however, the route that is most suitable for industrial purposes may be incompatible with other uses, such as shellfish harvesting, that could be disrupted or destroyed by the construction and/or physical presence of a pipeline.

The method commonly used by the petroleum industry in identifying corridors suitable for pipeline development is relatively straightforward and involves few unknown factors. By the time industry begins the siting process, the question of whether or not a pipeline will be built has already been resolved. The industrial siting decision is made on the basis of where marketable quantities of oil or gas are found (the pipeline's origin), and where the products will be taken (the pipeline's destination). The pipeline routing issue then become a matter of determining the best route for the line between the two identified points. Site-specific information and pipeline construction and design criteria are subsequently utilized in determining the precise location of the line. This siting method usually yields a detailed plan that plots the narrow corridor where construction will occur. It does not normally consider environmental as opposed to construction hazards.

The process described here delineates a corridor or corridors within which final industry decisions to construct a pipeline may be made. Public goals of conserving marine resources and supporting the development of offshore oil and gas resources in an environmentally responsible manner are the driving force in discussions with industry. With respect to these goals, the solution to the planning problem strives to balance the relationship between the environment and its use by man for pipelines.

The definition of the relationship between the environment and pipelines involves two fundamental issues (Wickersham, Hausen, Melcher, 1975).

- What limitations and opportunities does the existing environment pose to pipelines?
- What impacts will the proposed activity have on the environment?

A synthesis of the answers to these questions is collectively referred to as suitability. For the purpose of this study, suitability is defined as the level of appropriateness for locating a pipeline in an area based on both the ability of an area to provide the opportunities needed to support the construction and operation of a pipeline, and the ability of the environment to cope with a predictable range of adverse effects caused by pipeline activities. Clearly, suitability is a relative, not absolute, term.

The steps in the suitability methodology for determining offshore pipeline corridors are listed below. This methodology is limited to technical considerations.

1. Identification of Primary Interest Groups and Their Objectives. The identification of primary interest groups and their objectives clarifies the purposes for which the study is being undertaken. All studies that deal with locating pipeline corridors must at a minimum reflect the objectives and needs of relevant petroleum industries who actually site, construct, operate and maintain pipelines. Any pipeline study conducted by a non-industrial group would probably be concerned with locating corridors from different perspectives, e.g., preventing adverse impacts, than those of industry. Those groups whose concerns will influence siting decisions should be identified.

2. Identification of the Study Area. The size of the study area and the amount of land, water and submerged bottoms contained within that area determine the amount and type of information which must be compiled, the scale and number of maps to be used, and to a degree the cost of the study. Study areas can be defined in terms of geographic and/or legal boundaries. Because the users of this type of study may include officials at all levels of government (including legislators), and environmental and industrial groups, the study area should be defined using those boundaries which are commonly used in the region.

3. Description of Pipeline Activity. A relatively detailed description of the activities associated with pipelines is necessary to understand the manner in which the construction and operating requirements affect pipeline siting. Because a primary concern in this activity is the environment, the manner in which pipeline activities can affect coastal

resources must be described. The physical and chemical characteristics of the oil and gas to be transported, and the potential of the line to leak and spill oil should also be discussed. Information obtained in this step will lead to the identification of siting considerations which will be used to develop guidelines for assessing the suitability of particular areas.

4. Identification of Siting Considerations. Siting considerations are those factors which determine where pipelines can and cannot be located. Siting considerations are derived from understanding the needs of industry and public concerns for coastal resources. Sub-steps for industrial siting considerations include:

    a) identification of coastal features (resource units) and processes which affect pipeline siting.
    b) description of characteristics of coastal features and processes in terms of their potential to enhance or constrain pipeline placement, construction or safety.

Sub-steps for coastal resource considerations include:

    a) identification of resources and uses of those resources which are likely to be affected by pipeline activity.
    b) description of resource characteristics that may be adversely affected by pipeline activities.
    c) identification of general measures which can be implemented during construction to reduce adverse environmental impacts.

5. Determination General Capability of Study Area to Fulfill Siting Considerations. Once an understanding of the full range of siting considerations is achieved it is possible and indeed essential to make a general determination as to whether the features present in the study area can accommodate industrial needs as well as environmental concerns. If it appears that the study area is capable, first, of providing the opportunities needed to support pipeline construction and operation and, second, absorbing anticipated adverse effects, it then becomes appropriate to proceed to evaluating the suitability, or appropriateness, of the area for pipeline activity.

6. Identification and Inventory of Siting Considerations in Study Area. Completion of this step requires depicting, usually on maps, the location extent of the siting considerations such as conflicting coastal uses, within the study area. An inventory of specific considerations provides information for developing overlay maps to present a comprehensive image of constraints and opportunities for pipelines in the study area.

7. Developing Evaluation Guidelines. Guidelines are developed to determine the appropriateness for locating a pipeline within a particular area. Levels of appropriateness are defined as being high, moderate, or low depending upon risk to coastal resources or the potential for pipeline siting problems.

8. Applying Guidelines to Study Area. This activity evaluates the study area in terms of siting considerations and its ability to fulfill the guidelines developed. The product of this step is a set of composite maps and narratives.

9. Delineating Areas Most Suitable for Development. This activity identifies and discusses those areas which are suitable, conditionally suitable or unsuitable, given industry's and coastal resource management purposes, for oil and gas pipelines.

Additional steps in the process can be completed as constraints are relaxed. For example, if the source and destination of the OCS gas and oil becomes known, the following steps can be performed.

1. Identification of Inland Destination Points. Onshore research is conducted to determine likely landfall sites and inland destination points. This step in our study involved the identification of coastal land use and existing and proposed plant facilities in both Virginia and adjacent states as well as an assessment of long-range industry plans for the Virginia region.

2. Meeting with Primary Interest Groups. All representatives of primary interest groups are brought together to discuss the benefits and costs of alternative landfall sites. A meeting of this type, ideally, should give decision-makers a good idea of the possible range of important trade-offs.

3. Determination of Specific Corridors. If it appears that offshore petroleum will be transported via pipelines, industry and government can determine specific construction corridors. Specific sub-steps include:

   a) evaluation of previously identified broad corridors--are they still suitable?
   b) if necessary, begin conducting site-specific research to determine the exact location of the narrow construction corridor,
   c) if not, redefining broad corridors,
   d) preparing the environmental impact statement, including specification of the mitigating measures which would be required, when narrow corridors have been defined.

INDUSTRIAL SITING CONSIDERATIONS

The effect of many interrelated offshore and onshore processes on the cost of pipelaying from a "cost-prohibitive" angle, and their influence on the need to protect the pipe throughout its useful lifetime, must be considered by pipeline planners when evaluating alternative pipeline routes. These factors also affect "pipelining productivity," or the length of pipeline that can be completed in a given amount of time. The total time that a pipeline crew and their equipment must be employed, which is influenced by geological conditions along the route, is critical in determining the total cost of a project. Construction time is also influenced by whether or not the pipeline is to be buried. Burying pipelines, as opposed to simply laying them on the bottom, considerably increases both equipment requirements and time required to complete a pipeline route. Thus, the submarine features of an area play a major role in the selection of final pipeline routes. The construction of sub-sea pipelines is also influenced by other uses of the coastal waters as well as the availability of right-of-way for landfalls.

Industrial siting considerations are summarized in Table 1. Illustrated are the kinds of physical features most and least preferred by industry for construction purposes. Indeed, pipelines can be constructed just about anywhere as demonstrated by the completion of pipelines in areas of extreme construction difficulty such as Alaska and the North Sea.

The major constraints to pipeline routing are not so much related to engineering or technical problems as to existing uses that preclude situating pipelines in certain areas. Many of these uses include submarine wrecks, telephone cables, military restricted areas, unexploded ordnance areas and periodically dredged channels. Commercial fishing areas also influence pipeline placement but do not necessarily permanently preempt pipeline routing. The physical features which may present significant engineering problems to safety of the line during the operation phases are submarine sand waves and bluffs, dunes and beaches in areas of significant shoreline erosion.

The single most important industrial siting criterion for offshore pipelines is that they should follow the shortest possible route because of their very high unit length cost. Submarine pipelines are roughly three times more expensive to construct than terrestrial pipelines. Great depths and steep slopes complicate the construction process and may result in modifications of the route. Pipeline routes generally avoid hazardous underwater objects, active faults, rock out-crops, mud slide areas, and areas which are environmentally sensitive or are likely to generate strong public opposition.

TABLE 1 —INDUSTRIAL PIPELINE SITING CONSIDERATIONS

CONSIDERATIONS	MOST PREFERRED FEATURES	LEAST PREFERRED FEATURES
Coastal Waters		
Submarine Topography	Level or gradually sloping grade, relatively stable contour.	Continual, drastic up and down grade changes, dynamic contour.
Submarine Sediments	Light sediments, easily removed (sand or sandy loam), horizontal homogeneity over line length, stable sediments over full range of local current velocities.	Heavy sediments, not easily removable, which require loosening before removal (mud, clay gravel and rock), continual changes in sediment composition over line length, dynamic sediments within range of local current velocities.
Submarine Sand Waves	No presence or historical presence.	History of formation and presence.
Coastal Edges		
Shoreline Sediments	Homogeneous (non-layered), stable, high bearing strength, low water table, non-"runny" soils.	Diverse texture layers, unstable, low bearing strength, high water table, "runny" wet soils.
Barrier Islands	Sandy ocean front, relative historical stability, little wetland or bay area landward of shore breach.	Heavy sediment ocean front, significant historical migration and tidal inlet formation, large wetland or bay expanse between island and mainland.
Beaches	Accreting, sandy beach with historical stability (long-term and during storm activity).	Eroding, heavy sediment ocean front with a history of significant normal and storm-induced erosion.
Onshore Sand Dunes	Small in size with historical erosion levels small in magnitude.	Large in size, with historical erosion levels large in magnitude.
Wetlands	Firm soil conditions (high trafficability) with no obstructions such as tree stumps.	Soft, mucky soil conditions (low trafficability) with many obstructions which are hard to remove.

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TABLE 1—INDUSTRIAL PIPELINE SITING CONSIDERATIONS Cont.

CONSIDERATIONS	MOST PREFERRED FEATURES	LEAST PREFERRED FEATURES
Bluffs	Small in size with a history of relative stability and no history as run-off area.	Large in size, with a history of erosion and recession from the water's edge, and a known run-off point for upland storm, flood and waste waters.
Special Coastal Uses		
Commercial Fishing Areas	Areas in which no bottom-disruptive fishing techniques are employed or foreseen to be, and areas which are not controlled by private lease, license or the like.	Areas in which dredges, bottom trawling, tongs and the like are used in harvesting fishery products, areas which are privately leased or granted.
Wrecks	Areas which contain no wreckage.	Areas which have wrecks requiring circumvention.
Ship Channels and Anchorages	No major or minor channels which require periodic redredging of the route, no anchorage area harboring large commercial vessels in the route.	Periodically dredged channels; commercially utilized heavy anchorage areas.
Areas of Unexploded Ordnance	No designated explosives dumping grounds or live ammunition practice firing areas in the area, no record of accidental ordnance release.	Nearby areas of past unexploded ordnance disposal or live ammunition practice firing areas; records indicating possible presence of accidentally released live ordnance.
Other Special Uses		
Bridge Tunnel Area	No bridge-tunnel crossing the proposed pipeline route.	One or more bridge-tunnels which must be traversed by the pipeline.
Buoy Testing Areas	No buoy testing area to be traversed.	One or more buoy testing areas to be traversed.

TABLE 1—INDUSTRIAL PIPELINE SITING CONSIDERATIONS Cont.

CONSIDERATIONS	MOST PREFERRED FEATURES	LEAST PREFERRED FEATURES
Areas of Surface and Bottom Activity Restrictions	No areas of activity restriction to be traversed.	One or more areas of activity restriction to be traversed.
Prohibited Areas	No prohibited areas to be traversed.	One or more prohibited areas to be traversed.
Cable Areas	No cable areas to be traversed.	One or more cable areas to be traversed.
Rights-of-Way	Pre-existing utility rights-of-way, or easy to obtain, inexpensive and not likely to generate public oppostion.	"Frontier" area, devoid of existing utility rights-of-way, hard to obtain, expensive and likely to generate public opposition.

Preferred topography for a shore approach is a gently sloping bottom with sufficient thickness of unconsolidated sediments to allow not less than three feet of sediment to cover over the pipeline in areas of fifty foot water depth to low water level and burial at least ten feet deep in dynamic areas such as the surf zone (Hickman, 1977). Areas subject to significant seabed shifting resulting from strong tidal flows or other processes are generally avoided. Erosion caused by such action could undermine the pipeline, placing additional stress on the structure and possibly causing it to fail. A pipeline company usually prefers landfall sites which allow for a flat approach and reasonably gentle transition from the marine to land environment. Preferred landfall areas seldom include marshes or bluffs.

In summary, the primary constraints to the siting of pipelines in coastal environments are related to the costs to industry in circumventing special coastal use areas and the purchasing of rights-of-way through private lands and preferred construction features.

COASTAL RESOURCE SITING CONSIDERATIONS

Coastal areas naturally contain resource features of value in one way or another. Although some resources are renewable, over-use can and has resulted in a depletion of some. The resources in the transition area between shorelands and tidal waters are part of an especially fragile ecosystem, the equilibrium of which is easily upset by man's activities.

Pipeline construction can upset the equilibrium of coastal resources, if allowed to occur without adequate regard for associated environmental impacts. Coastal resource siting considerations reflect the perspective that many organisms and their habitats are valuable and consequently require protection from adverse impacts. Thus, opportunities for pipeline siting are constrained by the identification of those biologically-significant areas that are especially sensitive to pipeline activities and require that they are either avoided or protected through the implementation of recommended mitigating measures.

Impacts on coastal resources from pipeline activities vary depending upon the kinds of factors present at the time of the activity. Given such variables as climate, time of year, physical and chemical conditions and these relationships with the species present in an area, adverse impacts on coastal resources would fall within a generally predictable range. Correspondingly, measures that may be implemented to reduce adverse impacts vary greatly according to the nature of particular impacts. This paper describes a possible range of impacts and mitigating measures that should be required in the event that pipelines traverse sensitive environments in the coastal zone.

Impacts from construction activities often are more severe along the coast than in coastal waters because of the concentration and diversity of living and non-living resources at the land-water interface. Special construction procedures are necessary to protect the integrity of the estuarine ecosystem which includes beaches, dunes, barrier islands, and marshes. Construction activities disrupt soil, vegetation, and animal habitats. However, the severity of the impact depends greatly on the characteristics of the site, weather conditions at the time of construction, time of year and practices used to ameliorate anticipated impacts. On flat, upland sites, impacts may be temporary, since severe erosion of disturbed soils should not occur, and vegetation and habitat effects would be localized, providing that the site is restored to pre-construction conditions. However, where pipelines cross rivers and wetlands, the impact potential is much greater. Disruption of soils during construction would cause erosion and downstream sedimentation to increase, affecting both aquatic and terrestrial habitats. Long term modifications in water quality, water table levels, and vegetation could result if water-holding properties of the soil layers in wetlands are not restored to pre-construction conditions.

In summary, environmental impacts are primarily related to construction activities, are relatively short-term in duration and are concentrated, for the most part, in the immediate area of the trench. Table 2 summarizes coastal resource siting considerations, adverse effects that would probably result from pipelaying (construction) activities, and the general measures that can be implemented by industry to reduce these impacts. Because no severe long-term impacts are anticipated, pipelaying activities can be environmentally acceptable in many areas if appropriate mitigating measures are implemented. Therefore, the primary environmental constraints to the siting of pipelines in coastal environments are 1) the environmental impacts associated with pipelaying and 2) the industry costs involved in implementing impact-ameliorating construction practices (mitigating measures) in environmentally-sensitive areas, and/or 3) circumventing specific, exceptionally environmentally-sensitive areas.

Environmental impacts can be mitigated by employing construction and restoration techniques, by installing pipelines in the least environmentally sensitive areas during periods of least vulnerability, and by avoiding spawning periods. Specific measures for mitigating construction, as well as other impacts on coastal resources have been developed for the coastal environment in the Mid-Atlantic region and are discussed in Rooney-Char and Ayres (1978). Measures can be developed for other types of environmental areas by scientists familiar with those areas.

TABLE 2–COASTAL RESOURCE SITING CONSIDERATIONS

CONSIDERATIONS	PROBABLE IMPACTS	MITIGATING MEASURES
Coastal Waters	Sediment disturbance (increasing turbidity); possible changes in undersea current patterns along fish migration routes; possible contaminant resuspension. Nearshore: possible change in salinity; increases in Biochemical O_2 Demand, corresponding decrease in Dissolved O_2. Wetlands; the above impacts plus possible increased hydrogen sulfide and acidity.	Utilization of all possible sediment control measures. Nearshore, immediate backfill, utilization of proper waste disposal measures, avoidance of areas which may receive and hold bottom contaminants. Wetlands: dredging "in the dry," small working spreads.
Coastal Edges		
Barrier Islands	May include any impacts listed below for other geological forms, plus possible interference with normal migration and inlet formation.	May include any measures listed below for other geological forms, plus restoration and stable backfill.
Nearshore Shallows	Loss of plant and sedentary animal life in a 30 to 50 ft. wide path of the pipeline; possible disruption or destruction of spawning and protective nursery areas such as eelgrass beds; increased turbidity and siltation affecting adjacent areas.	Seasonal construction, immediate stable backfill, avoidance of eelgrass beds and contaminated areas, reconstitution and/or revegetation of resource areas disrupted.
Sand Beaches	Loss of sedentary fauna and flora in the 30-50 ft. wide pipeline construction corridor and in machinery paths; temporary closure to recreation.	Immediate stable backfill, erection of appropriate erosion control structures (with consideration given to sand-sharing systems), designation of zones of activity (traffic), seasonal construction.
Onshore Sand Dunes	Loss of vegetation in a 30-50 ft. wide path of the pipeline, and on areas of vehicular support traffic; possible increased erosion and/or reduced accretion.	Immediate stable backfill, revegetation, and protective covering on the backfill material and plants until established, erection of appropriate erosion control structures, designation of zones of activity (traffic).

TABLE 2—COASTAL RESOURCE SITING CONSIDERATIONS Cont.

CONSIDERATIONS		PROBABLE IMPACTS	MITIGATING MEASURES
Wetlands	**Vegetated**	Loss of plant and sedentary animal life in a 30-50 ft. wide path of the pipeline, possible disruption of spawning time and destruction of nursery areas for crustacean and finfish species, loss of wildfowl habitat, possible increased turbidity, hydrogen sulfide, chemical and biochemical oxygen demand, changes in salinity and acidity, disruption of tidal and groundwater flow, destruction of adjacent areas by support traffic and waste disposal, possible conversion of the marsh to shallow water habitat with poor water circulation, irregular tidal flushing, reduced water quality and fewer aquatic organisms.	Avoidance; or choice of route through wetlands of lesser value vegetation, seasonal construction, immediate stable backfill to original contour, revegetation and designation of areas for traffic and of non-wetlands areas for waste disposal. Construction should occur in marshes of narrow, rather than broad, width and done "in the dry" using the "push-pull" method and utilization of all possible sedimentation control measures.
	Unvegetated	Siltation may smother bottom dwelling organisms in adjacent areas and cause loss of food supply to finfish, crustaceans, and wildfowl in addition to those impacts listed under Vegetated Wetlands.	Except for revegetation and construction dredging "in the dry" mitigating measures are the same as listed under Vegetated Wetlands.
Bluffs		Accelerated erosion and increased sedimentation to adjacent waters, possible visual presence of erosion control or anchoring devices.	Immediate stable backfill and adjacent area stabilization, implementation of all appropriate sedimentation control measures.

TABLE 2 –COASTAL RESOURCE SITING CONSIDERATIONS Cont.

CONSIDERATIONS	PROBABLE IMPACTS	MITIGATING MEASURES
Living Resources		
Molluscs	Physical destruction of organisms in direct pipeline route, smothering by burial, or filter-feeding interference, siltation interference with: egg and larval buoyancy, respiration, oyster ability to "set", feeding and physical form by abrasion; beds impacted by propeller currents and barge grounding at low tide.	Avoidance of mollusc concentrations, seasonal construction, use of sedimentation control measures, transplantation of oysters; designation of a "zone of activity" for pipeline construction and periodic pipeline inspections.
Fishery	Pipeline area may become dangerous to fishing because of potential damage to fishing equipment or pipeline; area use precluded short-term by presence of construction vessels, contaminant resuspension may affect marketability.	Burial of pipeline to appropriate depths, notification of fishing interests, location of line on navigation charts, financial reimbursement to damaged parties, suitable abandonment procedures.
Crustaceans	Possible limited kill due to propeller action, temporary movement of crustacea away from zone of construction activity; increased siltation may cause changes in egg and larval buoyancy, and interference with respiration, food supply and normal behavior. Silt plume may affect egg, larval, and adult forms by physical abrasion.	Avoidance of areas of critical habitat, especially the bay mouth (seasonal), avoidance of activity in proximity of shedding plants; seasonal construction; avoidance of blasting; implementation of all possible sedimentation control measures; "zone of activity" designation and regulation, periodic pipeline inspections.
Fishery	(Same as Mollusc Fishery)	(Same as Mollusc Fishery)

TABLE 2—COASTAL RESOURCE SITING CONSIDERATIONS Cont.

CONSIDERATIONS	PROBABLE IMPACTS	MITIGATING MEASURES
Finfish	Siltation may affect food supply, organism buoyancy characteristics and respiration, egg and larval forms by physical abrasion, chemical and biochemical oxygen demand, and social behavior; possible changes in migration routes.	Avoidance of known spawning, nursery, and feeding areas; implementation of all possible sedimentation control measures; correction of all major changes in bottom contour; avoidance of blasting or use of non-lethal scare techniques; periodic pipeline inspections.
Fishery	(Same as Mollusc Fishery)	(Same as Mollusc Fishery)
Coastal Birds	Loss of habitat, displacement, general disturbance and fatality of young birds with limited mobility and heavy parental dependence. Sedimentation and resuspended pollutants may affect food supplies.	Avoidance of principle nesting, and feeding areas, particularly on barrier islands; seasonal construction; minimal support and inspection traffic through nesting areas.

GUIDELINES FOR EVALUATING CANDIDATE PIPELINE ROUTES

Generally, an ideal situation with respect to pipeline construction might be described as one in which physical features pose few major problems to construction and where biological resource values are relatively insignificant, thereby minimizing the potential for adverse environmental impacts. In addition, the ideal situations would occur in areas where conflicts over uses are non-existent or would present little or no obstacle to the acquisition of right-of-way. Unfortunately, these situations rarely if ever exist. As a result, pipeline corridors and ultimately pipelines must be located on the basis of constraints rather than opportunities; those areas that reflect the lowest relative cost and path of least resistance, i.e., the route with fewest constraints, would be those most preferred.

The importance of a particular constraint varies according to the site. For example, although physical constraints are not usually considered to be of major importance because advancements in the "state-of-the-art" allow for the installation of pipelines even in extremely hostile environments, there are exceptions. The often unpredictable effects that shoreline erosion has on barrier islands, for example, significantly limits their consideration for selection.

Since the best interests of neither pipeline companies, their clients, nor those with conflicting claims will be served by drawn out, expensive legal contests, the best possible strategy for corridor selection lies in the careful screening of candidate sites. This permits the early identification of major limitations on and, indeed, opportunities of an area for development by pipelines.

The identification of constraints and their relative significance is the basis for developing guidelines to evaluate the characteristics of candidate areas. The outcome of this assessment indicates whether or not an area is generally suitable. Guidelines, therefore, serve as decision parameters. They are derived by knowing which characteristics of an area negatively influence its suitability for development by pipelines. This knowledge originates from two sources; 1) concerns of the primary interest groups, and 2) the inventory of siting considerations. The primary interest groups indicate whether to positively or negatively evaluate the characteristics of an area with respect to the needs of pipeline activities. The inventory of siting considerations provides a data base by identifying the pipeline-related and environmental characteristics of the coastal area. By applying guidelines to the data base, the areas within the coastal region can be evaluated as exhibiting constraints to, or opportunities for, pipelines.

Constraints of industrial nature are apparent in the "Least Preferred Features" column of Table 1. The presence of these characteristics in an area may be viewed as a potential restriction on pipeline activity. Environmental constraints, or those imposed on the corridor designation process by coastal resources, are listed under "Probable Impacts" in Table 2. An area would be environmentally constrained if, first, significant resources were present and, second, if those resources displayed a significant degree of sensitivity to the kind of stress, or impacts created by pipeline activity. The significance of each constraint is determined on a case-by-case basis in consideration of the other limitations and opportunities present in a given area.

Constraints are grouped according to the manner in which they affect the corridor determination process. Some are of an engineering nature--those physical conditions which complicate or pose risks to the construction and operation of the line. Other constraints deal with right-of-way acquisition and involve the resolution of legal issues. The need to protect the resources, and their uses, in coastal environments imposes still another set of constraints upon the process of planning for pipelines. In summary, an assessment of coastal areas for the purpose of determining their suitability for development by pipelines must identify if and where and of what significance problems (constraints) of the above types occur.

The lack of an easy-to-use formula is a problem in locating pipeline corridors. Admittedly, the process for determining the significance of a constraint as well as the following evaluation guidelines is highly subjective, that is, based on expert industrial and scientific advice. This paper reflects the author's best understanding of industrial and coastal resource concerns in the pipeline corridor planning process.

Industrial Guidelines

An area would be suitable for pipeline development, presuming that area was in line with or in proximity to origin and destination points, if the following conditions were met:

- the area is determined to be cost-effective during construction (construction cost effectiveness),
- there is a low probability of risks to the pipeline during operation (operation risks),
- there is a high probability that rights-of-way can be purchased or leased relatively quickly and at a reasonable cost (rights-of-way),
- there is a low probability that court suits would be initiated by users, property owners or interest groups (court suits), and
- there is a high probability that the anticipated adverse environmental impacts of pipeline construction would be sufficiently

insignificant that required permits would be approved (permit approval).

Cost Effectiveness. Cost effectiveness during construction is basically an engineering determination of pipeline productivity. The determination of the relative cost effectiveness of alternate routes for a pipeline requires careful evaluation of all the cost factors involved, including the time value of money.

- Right-of-way and permit acquisition costs are a function of pipeline length, amount of privately-owned as opposed to publicly-owned property, the number of pipelines to be installed, land value and land use.
- Design, material and equipment acquisition and construction costs are a function of pipeline size and length, soil geology and topography, and water use, environmental impact considerations, regulatory restrictions, the hazards of weather and human activities.
- Operation and maintenance costs are a function of payroll, pumping power, taxes, insurance and the amortization of the investment, the latter cost being by far the largest.
- Low revenue is a function of the delay should production be ready before the pipeline is complete.

Directly or indirectly, line length influences all these costs. Because of this, the shortest pipeline is almost always the most cost effective pipeline (Chilcote, 1978).

Operation Risks. Pipeline companies generally prefer not to route a pipeline through an area where existing physical conditions or uses could cause a leak, rupture or failure of the line after construction has been completed and the line is in operation. Areas where pipelines would be subject to scouring or bottom-disruptive uses, such as ship anchorages and certain kinds of commercial fishing (trawling), are not preferred locations for pipelines. If an otherwise suitable area is characterized by conditions that pose risks to pipeline operation, pipeline companies would have to determine first, the degree of risk involved, and second, the level of risk, e.g., 5% chance of rupture in 50 years, which they would be willing to accept.

Rights-of-Way. The decision-maker in the pipeline company has an idea, given other estimates such as construction costs and value of the products of a well, how much the company can afford to pay for rights-of-way. The decision-maker defines the limits of acquisition costs, which have been mentioned to be between 2.5 (NERBC, 1976) and 5% (Hughes, 1984) of the total initial project cost, for example, and the period of time the company is willing to spend on negotiations.

The acquisition of privately-owned lands which are sought by pipeline companies for rights-of-way can be a slow process if the owner does not wish to sell or lease his land. The degree to which eminent domain powers are applicable in situations of this nature needs to be resolved on a case-by-case basis.

Court Suits. The possibility of court suits carries with it implications of costly expenditures of time, money, and also public opinion. For example, the court action which halted exploration of tracts leased from the United States OCS Sale #40 in the Atlantic resulted in losses termed "incalculable" by one oil executive. Direct financial expenditures in interest alone amounted to approximately $123 million over the 18 month delay period (Carter, 1978).

Situations and conflicts requiring judicial resolution would probably arise before a pipeline finally commenced operations. Challenges by affected property holders to the potential issuance of permits and lengthy negotiations surrounding the rights of eminent domain and "fair market value" of property desired by industry are but two of many of these situations. Again, the industrial-decision maker should and probably would be fully aware of the possibilities of the occurrence of court suits and of the sacrifices that the company is willing to make.

Permit Approval. The last factor industry considers in assessing a site involves the permits that will be required for construction and maintenance activities. The construction of an offshore pipeline will necessitate dredging in Federal and probably state navigable waters which generally requires approval from the appropriate governmental body.

In the U.S., an Environmental Impact Statement (EIS) is prepared by the permitting agency which has been designated the Federal lead agency. Numerous agencies and interested parties at all levels of government, as well as private organizations and individuals, have an opportunity to review and comment on the draft EIS. The lead agency takes these comments into consideration in the preparation of the final EIS and their final decision on the permit. If anticipated impacts are such that the permit is denied, construction would not be allowed and another right-of-way would have to be sought.

Coastal Resource Guidelines

Pipelines may be considered an appropriate use in an area if:

o an area is determined to be capable of absorbing anticipated adverse impacts with no significant, cumulative impact to the system (adverse impacts), and

- o existing uses and users of the resource in the area are allowed to continue, or in special cases, be compensated (use of resource base).

Adverse Impacts. With respect to coastal resources, scientists with the expertise to determine the capability of an area to absorb impacts need to be consulted in fields of physical and biological oceanography, environmental sciences and fishery science. Potential environmental impacts need to be assessed in terms of their spatial, temporal and quantitative attributes, i.e., frequency of occurrence and areal scope (immediate activity area vs. widespread), duration (short vs. long term) and the degree to which they affect living resources and their habitat. Also, special attention should begiven to determining the range of potential secondary and cumulative effects of the impact-generating activity.

Use of Resource Base. Many individuals rely upon the resources associated with coastal waters for their livelihood as well as for active and passive recreation. Because most of the impacts associated with pipelines are considered to be fairly localized and short-term in duration, it is anticipated that the majority of coastal resources would continue to be available. It is conceivable, however, that in the immediate vicinity of the pipeline, industry may desire and attempt to curtail certain resource-dependent activities such as fishing, since some methods used in fishing pose a risk to pipelines. If pipelines are given the right-of-way, fishermen could be compensated for lost fishing opportunities. The Shetland Island fishermen experience in the North Sea has established precedence for this type of cooperative arrangement with the industry. The experiences and solutions utilized of various countries should be applied toward the resolution of similar situations.

APPLICATION OF EVALUATION GUIDELINES

An inventory of siting considerations displayed on maps indicates only the presence or absence of siting considerations but does not ascribe values to the inventoried elements. To determine suitability, evaluation guidelines serve as the means by which a value judgement (positive=opportunity, negative=constraint) can be rendered on the relative coincidence between the characteristics of an area and the objectives of the primary interest groups. Application of evaluation guidelines to a coastal regional data base leads to the production of composite maps and landfall tables on which the results of suitability assessment are displayed.

A map overlaying technique can be employed to illustrate the presence or absence of multiple siting opportunities and constraints. The maps represent a composite view of the pipeline-constraining elements which appear on inventory maps. Each element is considered in view of both the needs of the pipeline activity (industry) and the environment (coastal resources) and relies upon expert opinion in estimating the significance of each constraint.

For each major group of siting considerations, i.e., industry and coastal resources, a composite map is drafted by 1) overlaying the inventory maps describing the siting considerations of that group and 2) applying the evaluation guidelines discussed earlier in this chapter to the data on the maps. In this fashion, the areas where characteristics seem to constrain pipeline activities have been screened and depicted on two composite maps. The maps should be regarded as a graphic summary of the more significant problems which influence the pipeline corridor planning process. This process is illustrated below using Virginia as an example. The contents of the maps and tables would be expected to change if other regions are evaluated.

Composite Maps - A Graphic Summary of Constraints in Coastal Virginia

Figure 1, "Potential Impediments to Pipeline Placement, Construction or Safety," reflects industrial concerns. As displayed, the primary difficulties in siting and constructing pipelines in the Hampton Roads area of coastal Virginia are associated with private ownership of oceanfront land and existing coastal uses. Areas where special uses are present, such as weapons testing and target practice, wrecks, anchorages, spoil disposal sites, channels, unexploded ordnance, buoy testing and bridges, would either preclude pipeline passage altogether or require special conditional approval from the appropriate authorities. In addition, the map clearly illustrates the relative absence of natural constraints to pipeline placement, construction or safety. The only environmental process which places real, though not extreme, limitations on pipeline activities is shoreline erosion, especially along the oceanfront. Of the approximate total of 500 miles of coastal shoreline in Virginia (including the ocean front and bay system), it has been estimated that only roughly 210 miles experience erosion rates of greater than 3 feet per year. According to industrial representatives, these areas can either be avoided, or fortified with special construction measures if traversing highly eroding shoreline is unavoidable.

The composite map for coastal resources was developed by generating several intermediate level maps. Because the discussion of siting considerations for certain living resources required both a description of their uses as well as environmental characteristics, multiple single purpose maps were utilized in the inventory of molluscs and crustaceans. The intermediate level maps for molluscs, crustaceans and finfish were developed, using basic inventory data, to indicate the potential dangers to resources

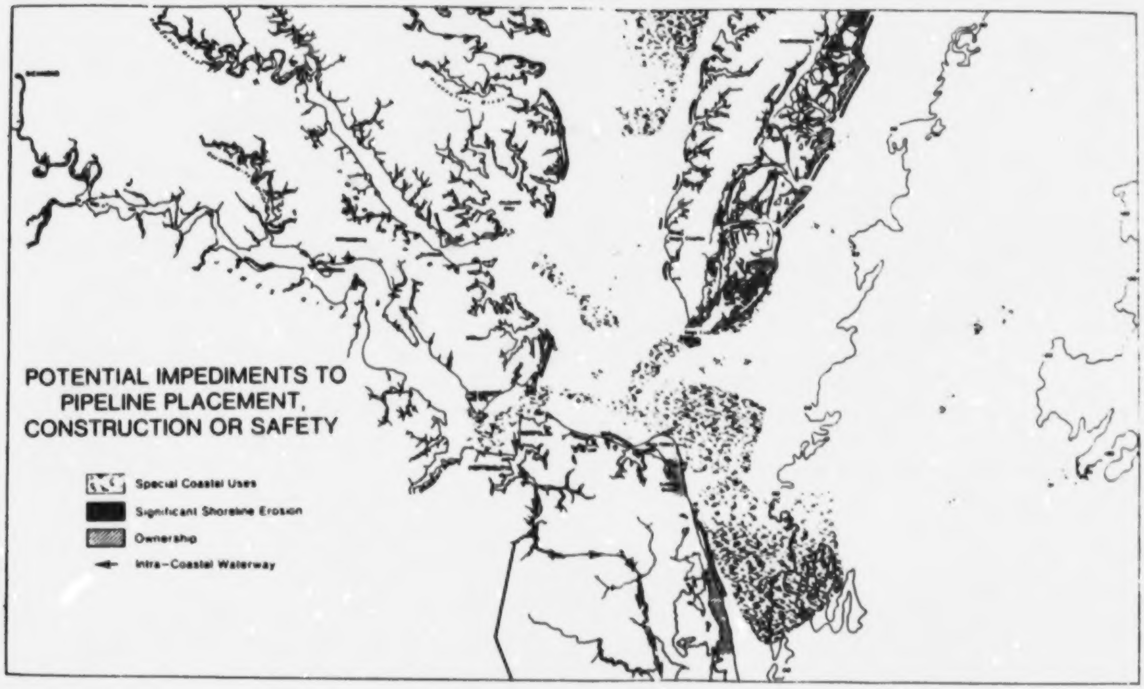
POTENTIAL IMPEDIMENTS TO PIPELINE PLACEMENT, CONSTRUCTION OR SAFETY
Special Coastal Uses
Significant Shoreline Erosion
Ownership
Intra-Coastal Waterway

Figure 1.

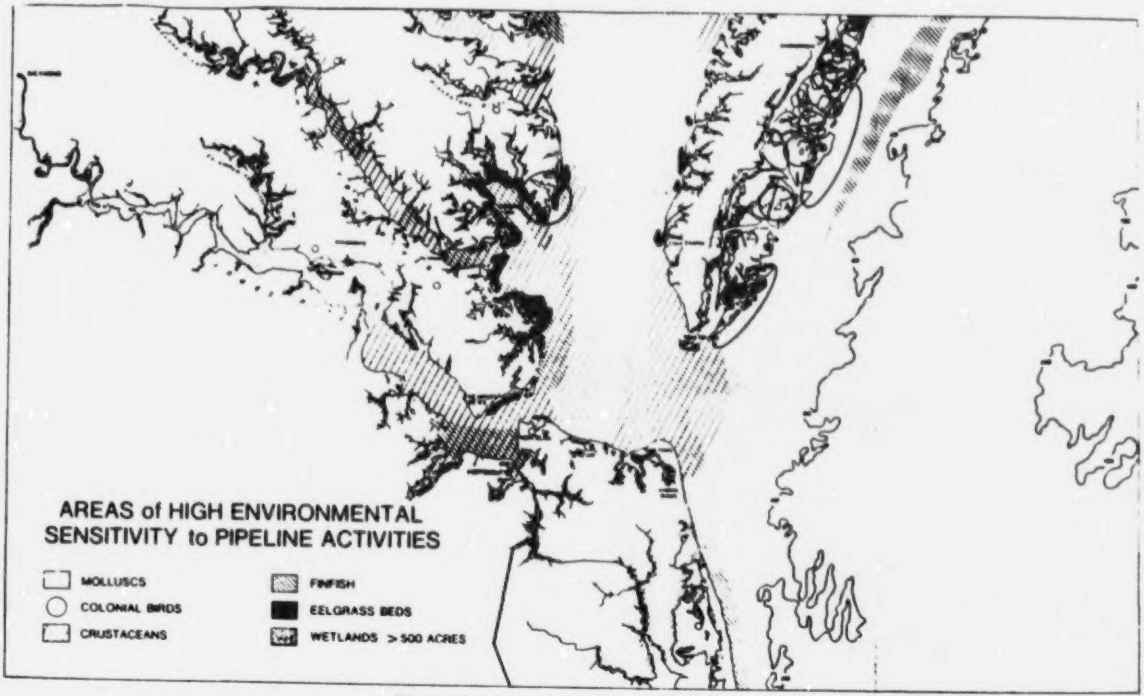
AREAS of HIGH ENVIRONMENTAL SENSITIVITY to PIPELINE ACTIVITIES
MOLLUSCS
COLONIAL BIRDS
CRUSTACEANS
FINFISH
EELGRASS BEDS
WETLANDS > 500 ACRES

Figure 2.

which could result from pipeline construction activities. Potential dangers to resources have been ascribed to areas on the maps using various levels of "risk".

Determinations of risk are a reflection of anticipated impacts on the resources themselves, their habitat, or their uses in the coastal area. A high level of risk refers to the potential for significant adverse impact and also indicates high environmental sensitivity to construction activities. Similarly, low or moderate risk determinations reflect the potential for low or moderate impacts on the resources present in a given area. The scales of relative value, e.g., very high, high, moderate, low, used in qualifying the risks to each major category of resource, vary from resource to resource depending upon the judgement of their respective experts.

Figure 2 is a coastal resource composite map entitled Areas of High Environmental Sensitivity to Pipeline Activities. Using Hampton Roads again as an illustration it depicts those areas which are environmentally significant and merit special consideration and protection prior to any alteration or destruction of the resources present. Pipeline activities, such as dredging and trenching, would probably severely damage or destroy any of the mapped resources in the immediate vicinity of the pipeline unless special precautions were taken. Important and environmentally-sensitive resources generally are present throughout coastal areas, and there is apparently no area where pipelines could cross without causing adverse impacts on one resource or another. However, it is important to remember that Figure 2 does not infer that pipelines cannot be constructed or that, if pipelines are constructed, a large environmental loss will be experienced. Rather, the important message of the map is: the primary impediment to pipeline construction in coastal areas is usually environmental in nature. This map shows the coastal resources and their location which are of particular concern to the Commonwealth of Virginia. The elements depicted here are the ones that industry should plan to protect if disruption of those resources by pipelines is unavoidable.

Landfall Tables

As previously noted, there do not apear to be any universally significant constraints to pipeline activity present in the waters off Virginia, with the possible exception of certain areas of known excessive sand wave activity. As one moves toward shore, however, the identification of suitable landfall areas becomes a more complex problem due to the potential for adverse impacts upon resources and competing uses associated with the coastal zone.

Table 3. SUMMARY OF LIMITATIONS TO PIPELINE PLACEMENT, CONSTRUCTION AND SAFETY IN NEARSHORE AND LANDFALL AREAS	Submarine Topography	Submarine Sediments	Submarine Sand Waves	Shoreline Sediments	Separation from mainland	Beaches	Sand Dunes	Wetlands	Shoreline Erosion	Commercial Fishing Areas	Wrecks	Ship Channels and Anchorages	Areas of Unexploded Ordnance	Surface Activity Restriction	Bottom Activity Restriction	Spoil or Disposal Area	Cable Area	Bridge Tunnel Area	Buoy Testing Area	Right-of-Way Determination		
																				Federal	State	Private
Assateague I.	X	X	X	X	O	X	X	O/X	O	O	O/X	O	X	X	X	X	O/X	X	X	O		
Wallops I.	X	X	X	X	X	X	X	X	O	O	X	O	X	O	X	X	O/X	X	X	X		
Assawoman I.	X	X	X	X	X	X	X	X	O	O	X	O	X	O	X	X	O/X	X	X			O
Metomkin I.	X	X	X	X	X	X	X	X	O	O	X	O	X	O/X	X	O	X	X	X			O
Cedar I.	X	X	X	X	O	X	X	X	O	O	X	O	X	X	X	O	O/X	X	X			O
Parramore I.	X	X	X	X	O	X	X	X	O	O	O/X	O	X	X	X	X	O/X	X	X			O
Hog I.	X	X	X	X	O	X	X	X	O/X	O	O/X	O	X	X	X	X	O/X	X	X			O
Cobb I.	X	X	X	X	O	X	X	X	O/X	O	O/X	O	X	X	X	X	X	X	X			O
Wreck I.	X	X	X	X	O	X	X	X	O	O	O/X	O	X	X	X	X	X	X	X		O	
Ship Shoal I.	X	X	X	X	O	X	X	X	O	O	X	O	O	O	X	X	X	X	X			O
Myrtle I.	X	X	X	X	O	X	X	X	O	O	X	O	O	O	X	X	X	X	X			O
Smith I.	X	X	X	X	O	X	X	X	O	O	X	O	O	O	X	X	O/X	X	X			O
Fisherman I.	X	X	X	X	O	X	X	X	X	O	O/X	O	X	X	X	O	X	X	X	O		
Chesapeake Bay Mouth	X	X	X	NA	NA	NA	X	NA	NA	O	O/X	O	X	O	O	O	X	O	O	X		
Fort Story	X	X	X	X	X	X	X	X	O/X	O	X	X	X	X	O	X	X	X	X	X		
Virginia Beach	X	X	X	X	X	X	X	X	X	O	X	X	X	O	X	X	X	X	X		X	O
Camp Pendleton	X	X	X	X	X	X	X	X	X	O/X	O	X	X	O	O	X	X	X	X		X	
Sandbridge	X	X	X	X	X	X	X	X	O/X	O	O	X	X	X	O	X	X	X	X		X	X
Back Bay	X	X	X	X	O	X	X	X	O/X	O	X	X	X	O	X	X	X	X	X	O		
False Cape	X	X	X	X	O	X	X	X	X	O	X	X	X	O	X	X	X	X	X		O	

X no apparent potential major problem for pipelines

O potential major problem for pipelines

Table 4. SUMMARY OF RISKS TO COASTAL RESOURCES IN NEARSHORE AND LANDFALL AREAS	Adjacent Coastal Waters	Unvegetated Nearshore Shallows	Shallows Grassbeds	Beaches	Onshore Sand Dunes	Vegetated Wetlands	Unvegetated Wetlands	Surf Clam	Sea Scallop & Ocean Quahog	American Oyster	Hard Clam	Soft Clam	Blue Crab	Menhaden	Summer Flounder (Fluke)	Croaker	Other Finfish	Colonial Birds	Sport Fisheries		
																			Mollusc	Crustacean	Finfish
Assateague I.	X	X	O	X	X	O		O	X	O	O	X	X	O	O	X	O	X	O	X	O
Wallops I.	X	X	X	X	X	X		O	X	X	X	X	X	O	O	X	O	X	X	X	O
Assawoman I.	X	X	X	X	X	X		O	X	O	X	X	X	O	O	X	O	X	O	X	O
Metomkin I.	X	X	X	X	X	X		O	X	O	O/X	X	X	O	O	X	O	O	O	X	O
Cedar I.	X	X	X	X	X	O		O	X	O	O	X	X	O	O	X	O	O/X	O	X	O
Parramore I.	X	X	X	X	X	O		O	X	O	O	O/X	X	O	O	X	O	X	O	X	O
Hog I.	X	X	X	X	X	O		O	X	O	O	O	X	O	O	X	O	X	O	X	O
Cobb I.	X	X	X	X	X	O		O	X	O	O	O	X	O	O	X	O	O/X	O	X	O
Wreck I.	X	X	X	X	X	O		O	X	O	O	X	X	O	O	X	O	O	O	X	O
Ship Shoal I.	X	X	X	X	X	O		O	X	O	O/X	X	X	O	O	X	O	O	O	X	O
Myrtle I.	X	X	X	X	X	O		O	X	O	X	X	X	O	O	X	O	O	O	X	O
Smith I.	X	X	X	X	X	O		O	X	O	X	X	X	O	O	X	O	O	O	X	O
Fisherman I.	X	X	X	X	X	O		O	X	O	X	X	X	O	O	O/X	O	O	O	X	O
Chesapeake Bay Mouth	X	NA	NA	NA	NA	NA		X	X	X	X	X	O	O	O	O	O	NA	X	O	O
Fort Story	X	X	X	X	X	X			X	X	X	X	X	O	O	X	O	X	X	X	O
Virginia Beach	X	X	X	X	X	X			X	X	X	X	X	O	O	X	O	X	X	X	O
Camp Pendleton	X	X	X	X	X	X			X	X	X	X	X	O	O	X	O	X	X	X	O
Sandbridge	X	X	X	X	X	O/X			X	X	X	X	X	O	O	X	O	X	X	X	O
Back Bay	X	X	X	X	X	O			X	X	X	X	X	O	O	X	O	X	X	X	O
False Cape	X	X	X	X	X	O			X	X	X	X	X	O	O	X	O	X	X	X	O

X · Low to Moderate Risk to Resource
O · High Risk to Resource

Composite maps are useful for depicting in a single glance the constraints present in the entire coastal area. These maps, however do not give the reader a strong sense of the constraints and levels of risks associated with areas of special interest, i.e., potential landfall areas. To meet this information need, tables are prepared which more clearly break down the data on the composite maps and summarize the implications of siting considerations for potentially suitable landfalls.

The main function of these tables, as indicated by the keys of the tables, is to identify the conditions associated with specific landfall areas which could present significant routing, construction or operational problems to industry due to the physical characteristics of various landfall areas, or the presence of or impacts upon significant coastal resources.

Using Virginia again as an example, the coast has been divided into potential landfall areas as displayed in the rows on each table. Local political boundaries or natural variations in geography can be used in categorizing landfall areas. Because a landfall is the place where the pipeline first emerges from offshore waters, only oceanfront areas, as opposed to inland locations, are segmented and evaluated. Potential landfall areas include 15 oceanfront barrier islands, 6 general areas on Virginia's southern shore, and the mouth of the Chesapeake Bay. The siting considerations pertinent to each primary interest group have been identified in columns.

For each interest group, major siting considerations have been supplemented by specific considerations which could significantly affect the location of pipeline. For example, Table 3, "Summary of Limitations to Pipeline Placement, Construction and Safety in Nearshore and Landfall Areas," lists a siting consideration which has been discussed in conjunction with others. The term "separation from the mainland" in the fifth column from the left refers to the relative distance between primary oceanfront landfalls like those on the barrier islands, and coastal fastlands where pipelines may be installed using conventional terrestrial methods. In Virginia, oceanfront lands are frequently separated from coastal fastlands by marshes, bays or inlets and these areas would be less desirable than areas where separation from the mainland is relatively small or nonexistent. Consequently, an area's "separation from the mainland" is another refinement on its desirability as a landfall site.

The table dealing with coastal resources, "Summary of Risks to Coastal Resources in Nearshore and Landfall Areas," summarizes risks to commercial fisheries listed along the column axis beginning with surf clams on the left to other finfish on the right. Sports fisheries and colonial birds are considered separately as indicated.

SUMMARY

Recent studies (Gowen et al, 1980) have shown that the impacts associated with the installation and operation of pipelines in the offshore and nearshore marine environment are generally short-term and localized. Nevertheless, certain concerns for the environment tend to be associated with pipeline siting decisions. The issues of concern relate to leaks or spills of oil into coastal waters as a result of pipeline failures; the potential for damage to sensitive marine environment and resources in the vicinity of the line from construction activities or spills; and the potential for loss of fishing areas or gear caused by the the presence of the pipeline. These concerns can be resolved by, first, identifying early in the planning process the areas in where conditions, e.g., geological hazards, conflicting coastal uses, are present that could cause failure of the pipeline, and the areas which pose a significant risk to sensitive marine resources and their habitats; and second, discounting these areas as candidate corridors or implementing special measures if they are otherwise the optimum areas for siting the pipeline.

Given this approach, this paper has presented a method, or more accurately a planning process, for siting marine pipelines in an environmentally responsible manner. The paper has described a sequence of planning activities, has identified specific although generalized industrial and environmental siting considerations, has developed decision guidelines for evaluating candidate areas, and has illustrated the process using the coastal area of Virginia as an example. The key to successful implementation of this methodology, however, is substantive and continuing dialogue between the private and public sector groups who have something at stake in the siting issue. With their full and active participation, it is possible to attain a satisfactory siting decision that achieves both industry and environmental goals.

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VANCOUVER ISLAND GAS PIPELINE PROJECT

K. Berry and D. Morris
Westcoast Transmission Company Limited

ABSTRACT

Many schemes have been proposed to extend natural gas service to Vancouver Island. In this paper, a brief overview of two current proposals is provided, along with a discussion of the marine routings and construction methods. If approval is obtained for construction, the Vancouver Island Pipeline will be the first deep water marine pipeline in Canada. The project, however, is presently caught in a lengthy regulatory review process, with two major corporations vying for the permit to construct. No decision is expected before mid-1984, and the matter of a government subsidy remains to be resolved.

PROJECT OVERVIEW

Applications to construct a high-pressure gas pipeline from the B.C. Mainland to Vancouver Island are currently being reviewed in a public hearing before the British Columbia Utilities Commission (BCUC).

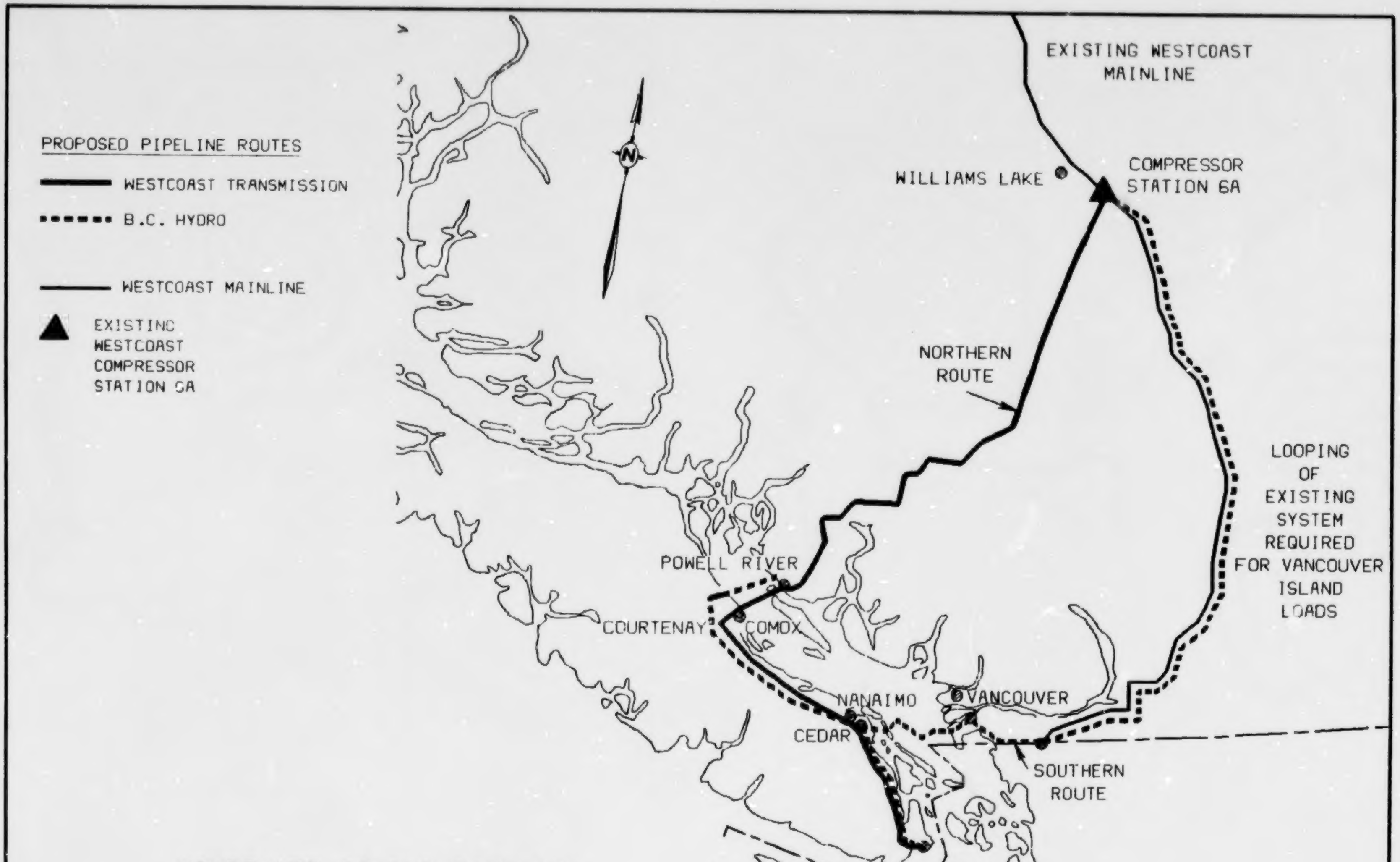
Two separate and very different propoals are being considered: 1) a "northern route" proposed by Westcoast Transmission Company Limited (Westcoast), from the B.C. Interior across the Fraser Plateau and the Coast Mountains, with an underwater crossing from Powell River to Little River, north of Comox, in the central part of Georgia Strait; and 2) a "southern route" proposed by B.C. Hydro and Power Authority, from the existing pipeline distribution system in the Lower Mainland, across the Fraser River Delta, with an underwater pipeline crossing the main channel of Georgia Strait, Valdes Island, and Stuart Channel, landing on Vancouver Island at Flewett Point, south of Nanaimo (Figure 1).

Characteristics of the northern and southern route proposals are shown in the following table (Table 1).

Project History

The Vancouver Island Pipeline project has had a long history. Many schemes have been proposed since the late 1950s, when natural gas from northeast British Columbia gas fields was first delivered to the Lower Mainland by the Westcoast pipeline system. Some early concepts for delivering gas to the Island involved the use of small diameter flexible pipelines linking the mainland and various Islands in the San Juan and Gulf Islands group. These schemes were abandoned because of technical difficulties in coupling sections

FIGURE 1


PROPOSED PIPELINE ROUTES
WESTCOAST TRANSMISSION
B.C. HYDRO
WESTCOAST MAINLINE
EXISTINC WESTCOAST COMPRESSOR STATION GA
EXISTING WESTCOAST MAINLINE
WILLIAMS LAKE
COMPRESSOR STATION 6A
NORTHERN ROUTE
LOOPING OF EXISTING SYSTEM REQUIRED FOR VANCOUVER ISLAND LOADS
POWELL RIVER
COURTENAY
COMOX
NANAIMO
CEDAR
VANCOUVER
SOUTHERN ROUTE
VICTORIA
N

VANCOUVER ISLAND PIPELINE
PROPOSED NORTHERN ROUTE AND SOUTHERN ROUTE

TABLE 1 CHARACTERISTICS OF NORTHERN AND SOUTHERN PIPELINE CORRIDORS - VANCOUVER ISLAND GAS PIPELINE PROJECT

	NORTHERN ROUTE OPTION	SOUTHERN ROUTE OPTION
Route	Williams Lake - Gold Bridge - Hurley River - Lillooet River - Meager Creek - Elaho River - Sims Creek - Casement Pass - Queens Reach - Eldred River - Powell River - Little River (Comox) and Laterals to Squamish, Woodfibre and Port Mellon	Tilbury - Brunswick Point - Roberts Bank - Valdes Island - Flewett Point (Nanaimo). Laterals from Comox to Powell River and Ioco to Squamish, Woodfibre and Port Mellon.
Approximate Length & Size of New Pipeline	Overland - 390 km of 406.4 mm O.D. Mainline 77 km of 168.3 mm O.D. Squamish Lateral 49 km of 114.3 mm O.D. Woodfibre/Port Mellon Lateral Underwater - 32 km of 273.1 mm O.D. dual pipelines	Overland - 18 km of 508 mm O.D. Mainline (B.C. Hydro proposal) 55 km of Squamish Lateral (pipe size not established) 49 km of 114.3 mm O.D. Woodfibre/Port Mellon lateral 13 km of 914 mm O.D. looping of existing Westcoast mainline Underwater - 53 km of 406.4 mm O.D. dual pipelines 32 km of 219.1 mm O.D. lateral to Powell River
Use of Existing Gas Transmission System	Taylor to Williams Lake - 592 km	Taylor to Huntingdon - 1040 km
Approximate Length of Pipeline System to serve Island communities between Campbell River and Victoria, as well as Powell River, Squamish, Woodfibre and Port Mellon	Williams Lake to Powell River 390 km Powell River to Little River (Comox) 32 km Little River to Langford (Greater Victoria) 213 km Little River to Campbell River 40 km Sims/Elaho Rivers to Squamish, Woodfibre and Port Mellon 126 km TOTAL 801 km	Williams Lake to Huntingdon 449 km Huntingdon to Brunswick Point 76 km Brunswick Point to Flewett Point via Valdez Island 56 km Flewett Point to Langford (Greater Victoria) 97 km Flewett Point to Campbell River 164 km Island mainline to Powell River via Little River 43 km Ioco to Squamish via Indian and Stawamus Rivers 55 km Woodfibre/Port Mellon lateral 49 km TOTAL 989 km
Spin-off Effects	Some expansion (looping) of Westcoast's mainline upstream from Williams Lake would be necessary to transmit additional gas volumes to supply Vancouver Island. Initial phases of the project will capture more existing and potential industrial, commercial and residential users at Powell River, in addition to those on Vancouver Island. Potential for a lateral to serve Squamish. With the northern route, new industries using natural gas as feedstock (e.g petrochemical plant) can be developed at mainland tidewater locations as well as on Vancouver Island. Remote communities such as Gold Bridge, Powell River, Sechelt and Regional District of Squamish-Lillooet will benefit from employment opportunities, local purchases and increased industrial tax base. Local road improvements carried out as part of the pipeline project will benefit residents and tourists in the Hurley River - Gold Bridge area. The Squamish Lateral could be linked to Vancouver's gas distribution system to provide a "security loop" for the Lower Mainland.	Some expansion (looping) of Westcoast's mainline upstream from Huntingdon would be necessary to transmit additional gas volumes to supply Vancouver Island. No additional mainland communities served unless a lateral pipeline is constructed from the Burrard Thermal Plant along Indian Arm and Stawamus River Valley to Squamish, or a second underwater crossing is constructed to serve Powell River from Comox. With the southern route, Powell River would be dependent on two underwater crossings of Georgia Strait. Limited economic benefits would result from pipeline employment or local purchases in the diverse economy of the Lower Mainland.

of flexible pipe, and problems with the strong tidal currents and numerous rock ridges encountered in the channels between the islands.

In the mid-1960s a pipeline crossing in the far northerly part of Georgia Strait was investigated, a route which would leave the mainland near the mouth of Bute Inlet, and cross four narrow channels between the mainland and Dent Island, Quadra Island and Vancouver Island. This proposal would involve an overland approach through a remote rocky area at the head of Bute Inlet, as well as four aerial water crossings up the 730m in length, spanning waterways used as ship channels. This proposal was considered too costly and too remote, and the landing on northern Vancouver Island near Campbell River would be distant from the main population center, Greater Victoria.

In the late 1960s Westcoast commissioned pipeline routing studies to locate a corridor for a possible "western loop" to provide additional security for Lower Mainland markets, and also to link with an underwater pipeline to serve new markets on Vancouver Island. In 1967 an engineering consultant's field party travelling by foot, helicopter and pack horses, selected an overland corridor from the Cariboo area to the coast which was judged to be feasible for pipeline construction. Preliminary marine surveys in the Powell River - Cape Lazo segment of Georgia Strait were also conducted at this time.

Previous Regulatory Hearings

In response to a request from the government of British Columbia early in 1972, a number of companies submitted applications for an Island pipeline. A series of public hearings were subsequently held by the B.C. Public Utilities Commission, the forerunner of the present BCUC. Of the five applicants appearing at the 1972 hearings, three chose a northern route from Williams Lake to Powell River, and two proposed a southern route extending from the Lower Mainland area. After some three months of hearings in 1972, no decision was made, largely because of a change in the provincial government organization and policies, the local availability of other reasonably-priced fuels, the uncertainty of underwater pipeline technology at that time, and a temporary decline in provincial gas supplies.

An underwater pipeline constructed in water depths as great as 360m, as would be encountered in Georgia Strait, was at the limit of practical technology in the early 1970s.

The Project Reactivated

Interest in a gas pipeline link to Vancouver Island was revived in the late 1970s. By that time new gas reserves had been confirmed in B.C. and there were worries about uncertain oil supplies and high offshore oil prices which encouraged conversion to other fuels. In addition, the technology for installing and maintaining underwater pipelines had advanced significantly, and techniques for deep water pipelining had been tested in a number of locations such as the North Sea, the Mediterranean Sea, and the Gulf of Mexico.

Both Westcoast and B.C. Hydro reviewed their earlier work and initiated further studies, beginning in 1979 and continuing into 1980/81. B.C. Hydro conducted an intensive analysis of seafloor conditions over a wide area in Georgia Strait, and also completed a multi-disciplinary analysis of various corridor and route alternatives for a pipeline across the southern part of Georgia Strait. Both Westcoast and B.C. Hydro examined underwater conditions along a potential northern route, Powell River to Comox.

Both proponents subsequently prepared reports; the Hydro documents were circulated to government and the public in late 1980, but no opportunity was provided for others to submit applications. In February 1981 Hydro was given approval by the provincial Cabinet to proceed with the project. The Cabinet, in this case, elected to bypass a public hearing and award a certificate to a provincially-controlled Crown corporation. This decision was reversed later in 1981 following protests by various municipalities and public interest groups, led mainly by the Municipality of Powell River. The Powell River group was successful in lobbying for a re-examination of the northern route which they felt would be of greater benefit to their isolated mainland community.

When the provincial government issued a request for letters of intent from interested companies in December 1981, ten proposals were received. Three proposals were related to the delivery of liquefied natural gas (LNG) by tanker or barge; six proponents indicated an interest in all or part of a pipeline system; one intended to participate in financing and distribution.

Special Task Force

A special provincial task force under Robin J. Abercrombie, an energy expert, was established to examine the ten proposals and report to Cabinet. The Abercrombie report, published in February 1983, concluded that natural gas was a cost-effective energy option for Vancouver Island and that an underwater pipeline could be constructed safely and reliably with current technology. The LNG option was discarded because of lack of comparable data on costs. A pipeline was judged to be the only viable option for bringing natural gas to Vancouver Island.

The Application Phase

Following the Abercrombie investigation, the provincial government requested formal applications to be submitted in May, and BCUC hearings commenced in September 1983.

Westcoast, B.C. Hydro and Centennial Natural Gas Pipeline Limited applied to build and operate the mainland and underwater segments. Centennial, a Vancouver-based engineering group who participated in the 1972 hearings, withdrew from the 1983 application process when it became apparent that the review and public hearing would be both lengthy and costly.

Four companies made applications to construct the "on-Island" transmission system: 1) Westcoast Transmission Company Limited; 2) B.C. Hydro and Power Authority; 3) ICG Island Transmission Ltd.; 4) Inland Natural Gas Co. Ltd. Phase III of the BCUC hearings will consider the "on-Island" proposals.

B.C. Utilities Commission Hearings

Public hearings to determine a "to-Island" route and select a proponent began in late September 1983 and are still underway at the time this paper was written (March 1984). Some 72 days of testimony filling 14,000 pages of transcript were completed at the time of writing. Both proponents have submitted detailed cost estimates, schedules, photographs, videotapes and other exhibit material to describe and clarify their proposals. Each proponent has cross-examined the other on feasibility, cost-effectiveness and justification.

For the southern route the questioning focussed primarily on 1) schedule and cost of crossing Roberts Bank within the short window prescribed by Fisheries and Oceans Canada; and 2) cost and feasibility of laying two submarine pipelines through a narrow gap in underwater rock ridges along Valdes Island.

For the northern route, the cross-examination dealt primarily with cost, construction difficulty and reliability of the pipeline through Casement Pass, a narrow defile through the Coast Mountains at some 1500 m elevation.

In examining the two proposals the Utilities Commission is faced with an "apples" versus "oranges" comparison: a long overland route coupled to a short direct underwater segment, versus a long, highly complicated underwater route crossing the Gulf Islands, coupled to a short, overland segment.

A key aspect of the southern route proposal is the requirement to expand (loop) the existing Westcoast system in order to accommodate further Vancouver Island gas loads, and the need for up to two additional underwater pipelines from Comox to Powell River if Powell River is to be served via the southern route.

MARINE ROUTING AND CONSTRUCTION

By the late 1970s, submarine pipeline technology, initially developed to meet the requirements of oil and gas extraction and transmission in the Gulf of Mexico, the North Sea and Canadian Arctic, had advanced to the point where an underwater crossing of Georgia Strait was well within the capability of existing engineering design and construction methods. The feasibility of crossing Georgia Strait, a concern which was strongly voiced during the 1972 hearings, has been resolved. The two competing companies, B.C. Hydro and Westcoast, have both proposed different, but entirely feasible, methods of intalling a submarine crossing.

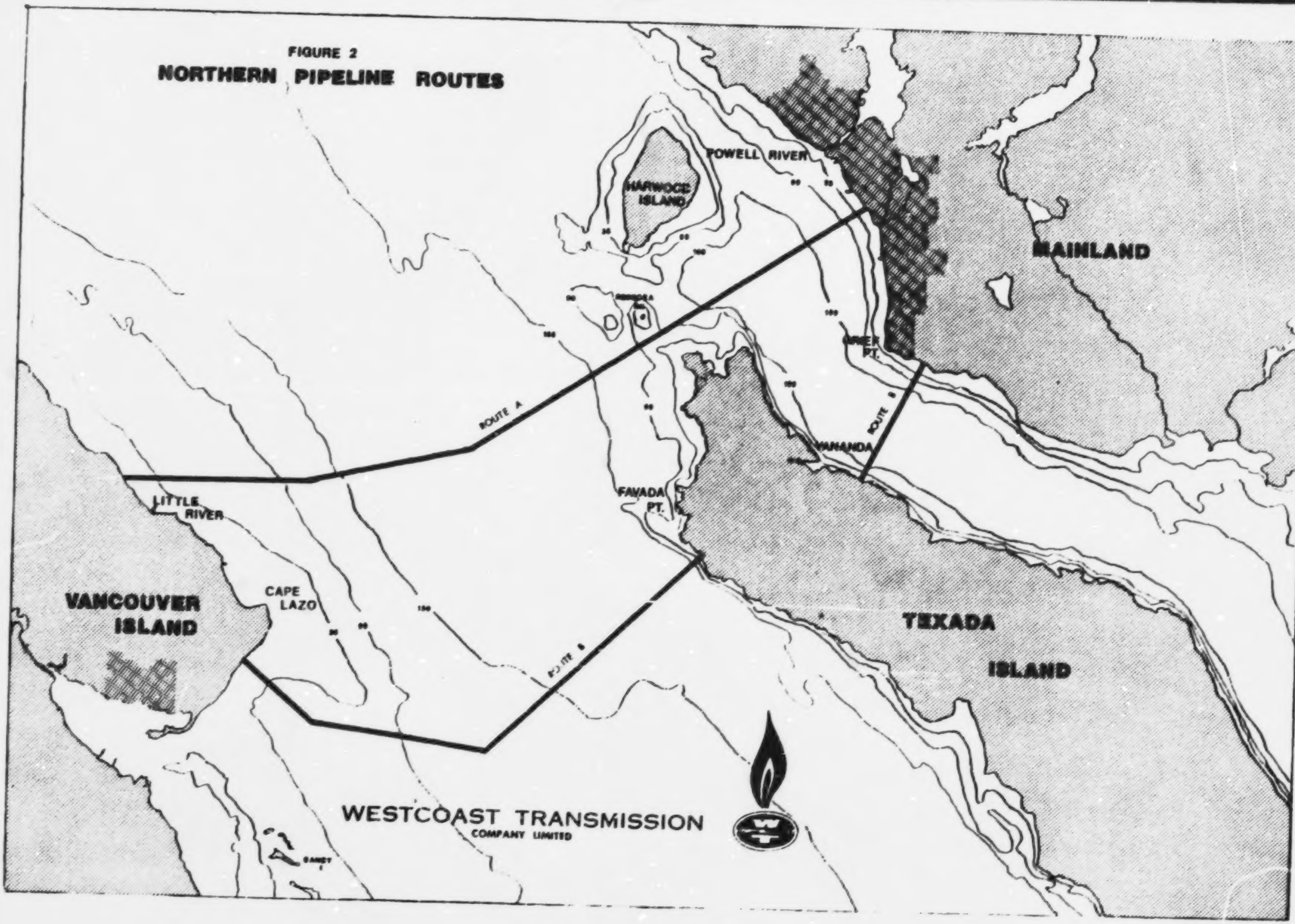
As described previously, two very distinct corridors have been proposed for the underwater gas pipeline to Vancouver Island. The 32 km northern corridor, proposed by Westcoast, would cross Georgia Strait from the Powell River area on the mainland to an island beachhead near Comox on Vancouver Island. The 53 km southern corridor, proposed by B.C. Hydro, would leave the mainland in the Municipality of Delta and cross the Fraser Delta (Roberts Bank) before crossing the Strait of Georgia to Valdes Island, one of the Gulf Islands. From Valdes Island, the pipeline would cross Trincomali and Stewart channel before reaching a beachhead near Flewett Point on Vancouver Island (Figure 2). Within these two broad corridors, each proponent has examined numerous feasible routes. The purpose of this paper is to discuss the various route options, examine the criteria each proponent used to nominate a preferred routing, and describe the construction methods proposed.

Both proponents drafted their applications to satisfy provincial requirements contained in the Environment and Land Use Committee's guidelines for linear development, now superceded by the Ministry of Energy, Mines and Petroleum Resources' Energy Project Review Process. In these guidelines, a proponent is requested to explore all of the feasible route alternatives and select a preferred alignment in terms of least environmental impact, least cost and maximum pipeline reliability.

Northern Route Options Proposed by Westcoast Transmission Company Limited

Prior to its presentation to the B.C. Utilities Commission in 1983, Westcoast completed preliminary geophysical studies to determine the feasibility of constructing a northern submarine crossing. This work included an analysis of existing work completed by the Geological Survey of Canada, and a 1966 submersible survey. The survey system used to examine the deep water portion of the northern crossing in 1980 was a Del Norte Trisponder System. This system utilized a number of fixed shore stations for exact positioning. During the surveys, acoustical data was collected using a combination of echo

FIGURE 2
NORTHERN PIPELINE ROUTES


POWELL RIVER
HARWOOD ISLAND
MAINLAND
GRIEF PT.
ROUTE A
ROUTE B
VANANDA
FAVADA PT.
LITTLE RIVER
CAPE LAZO
VANCOUVER ISLAND
TEXADA ISLAND
100
50
WESTCOAST TRANSMISSION
COMPANY LIMITED

sounding and hydrophones. This provided bottom profiling as well as sub-bottom profiling for the survey lines. Subsequent to these studies, Westcoast employed the use of a submersible remote-controlled Recon-J vehicle to obtain additional detail on specific areas of interest identified in the 1980 geophysical survey. This vehicle has the capability of providing precise positioning and an accurate visual recording of the sea bed. With this background data Westcoast settled on two candidate pipeline routes (Figure 2). The most northern of the two (Route A) extends a distance of 31.2 km and leaves the B.C. Mainland between Powell River and Westview, passing between Texada Island and Rebecca Rock and landing on Vancouver Island immediately north of Little River. The other route (Route B) extends some 33 km, of which 6 km is across Texada Island. The take-off point for this alternate is just south of Grief Point, from which the route crosses Malaspina Strait to a landfall north of Vananda, across Texada Island to Favada Point and then across the main part of Georgia Strait to a landfall on Vancouver Island between Cape Lazo and Comox.

The criteria for the selection of a feasible northern route included: favourable oceanographic and geophysical parameters, utilization of conventional submarine pipeline construction and repair methods, compatible land use at the beachheads, favourable environmental conditions, and cost.

The northern route (Route A) was selected as the preferred route option based on compatibility of land fall sites, gradual bottom slopes which are free of rock, fewer environmental concerns and lower expected costs.

Both landfall sites of Route A have easy road access and gentle appoach slopes which are predominantly sandy/gravelly beaches wth some cobbles. Both landfall sites are privately owned and presently undeveloped.

Starting on the Powell River side, Route A descends to a depth of 260m in the lowest portion of Malaspina Strait. Slopes average less than 5° and the bottom sediments are sandy clays and silts changing to soft green marine muds in the deeper waters. Approaching Rebecca Rock, the sea floor is comprised of a thick veneer of sands, gravels and soft holocene sediments overlying bedrock. To the west of Rebecca Rock, sandy deposits cover bedrock to a water depth of approximately 150m, after which the green soft marine muds again become the prominent surface material. Dipping to the 360m water depth in the Strait of Georgia basin, this mud layer continues to the 120m depth on the eastern foreslope of Vancouver Island. Shoreward, the soft marine sediments grade into clayey sands and gravels near Little River. No exposed rock was found along the preferred Route A based on surveys undertaken to date.

The bottom flora of the preferred Route A is comprised of a thin band of necrotic eel grass on the mainland subtidal zone. Both beachheads displayed little tidal zonation or species diversity. Sub-tidally, burrowing anemones and polychaete worms are quite common. The fauna of the Vancouver Island approach is somewhat more diverse than on the Mainland side. Rock sole, geoduck, scallop and shrimp species were identified proximal to the route.

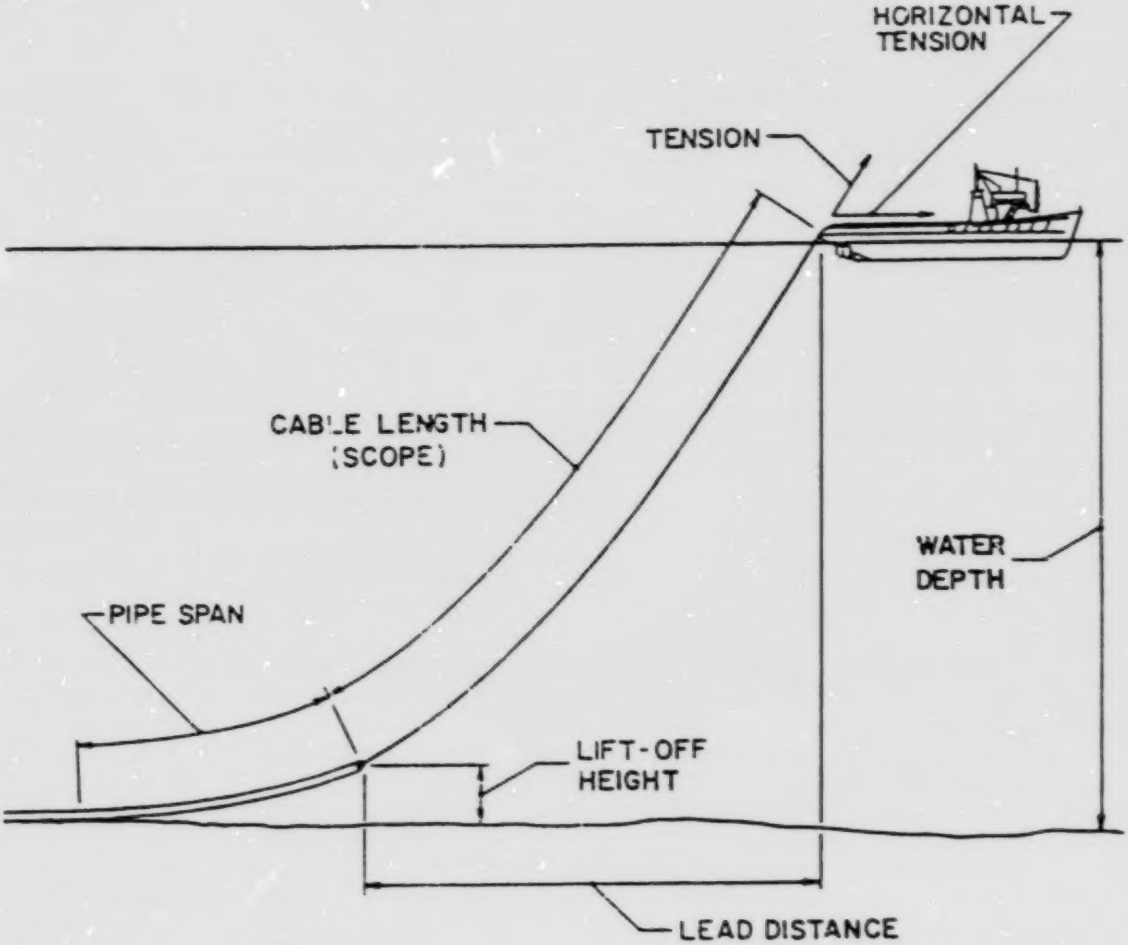
In contrast, the alternate route (Route B), which crosses Texada Island, is approximately two kilometers longer, has two additional landfall sites, and would involve difficult construction techniques. Approach slopes to Texada Island are steep with some exposed bedrock faces. The possibility of encountering hard sandstone formations in the vicinity of Cape Lazo also detracts from the selection of this route. In addition, the marine environment crossed by Route B is much richer and more diverse than the preferred Route A. The rocky shore approaches promote thick kelp beds which provide habitat for ling cod, herring, and young salmonids. Sponges, mysid shrimp, rock scallops and anemones are also prevalent along the rock ledges. Blasting which would be required to install a pipeline on these rock approaches would have significantly more environmental disruption than on the gentle sand/clay beaches of the preferred Route A. The additional length, landfalls, potential environmental perturbation, and difficult construction, effectively add to the overall cost of Route B, consequently the more direct Route A was selected as Westcoast's preference.

A short northern crossing of Georgia Strait has allowed Westcoast to propose a number of construction techniques, all of which have been tested on other submarine pipeline projects throughout the world. The variety of installation methods permits competitiveness in the bids, compared to the more complex southern crossing proposed by B.C. Hydro. Five possible installation techniques were examined for the northern crossing: laybarge; reel barge; bottom tow; off-bottom tow; and bottom pull. Each method has its specific advantages and disadvantages, and each was evaluated as to its adequacy to install twin 273.1mm (10.75"), 31.2 km pipelines in depths and conditions prevailing in the area. Examples of three potential installation techniques are identified in the following Figures 3, 4 and 5.

Westcoast anticipates burying the pipelines 1.2m to a water depth of 110m. This will allow for adequate protection from man-made hazards (e.g. anchors, drag lines, fish nets, etc.) and provide long term stability of the pipeline. Plowing, dredging and jetting are the three techniques proposed for this work. Of these, plowing is considered to be the most effective method because of the low submerged weight of the pipe, less environmental disturbance, availability of machinery, and cost.

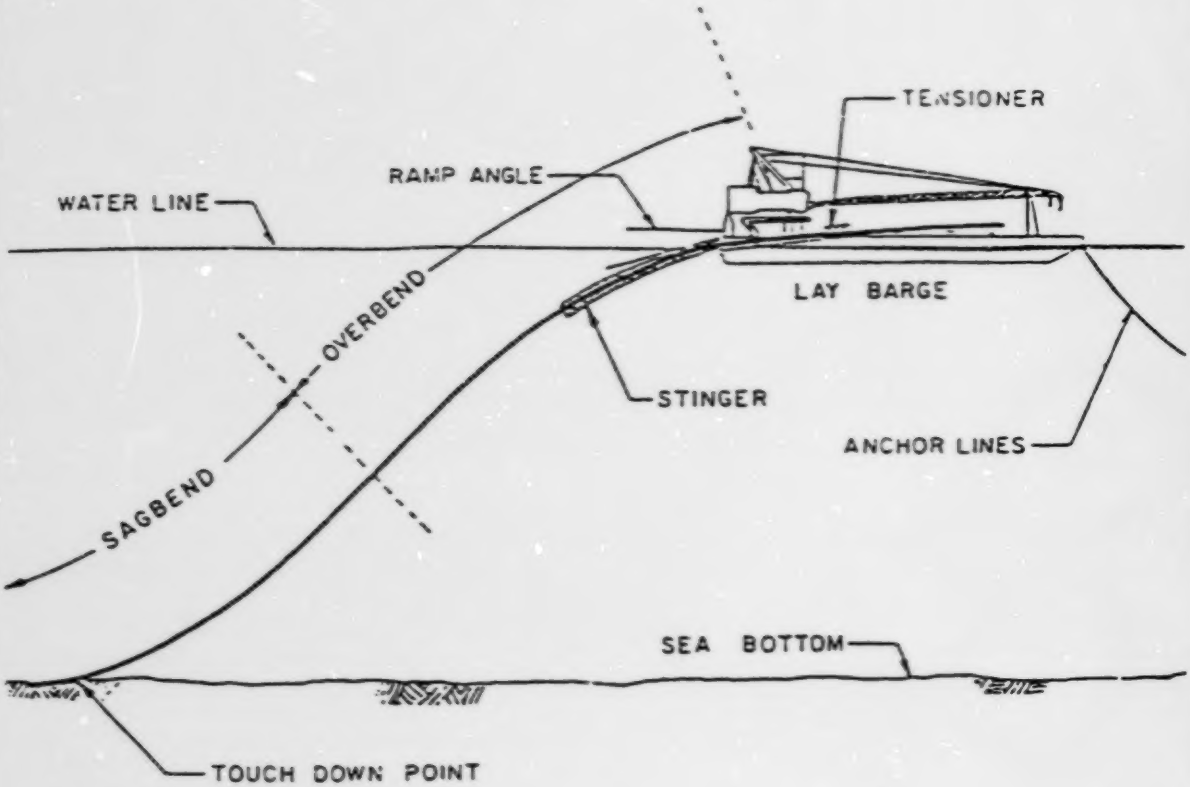
In summary, for the more direct northern route (A), a bottom pull installation and trenching by means of a plow, appears to be favoured for Westcoast's submarine pipeline crossing of Georgia Strait.

FIGURE 3


HORIZONTAL TENSION
TENSION
CABLE LENGTH (SCOPE)
WATER DEPTH
PIPE SPAN
LIFT-OFF HEIGHT
LEAD DISTANCE

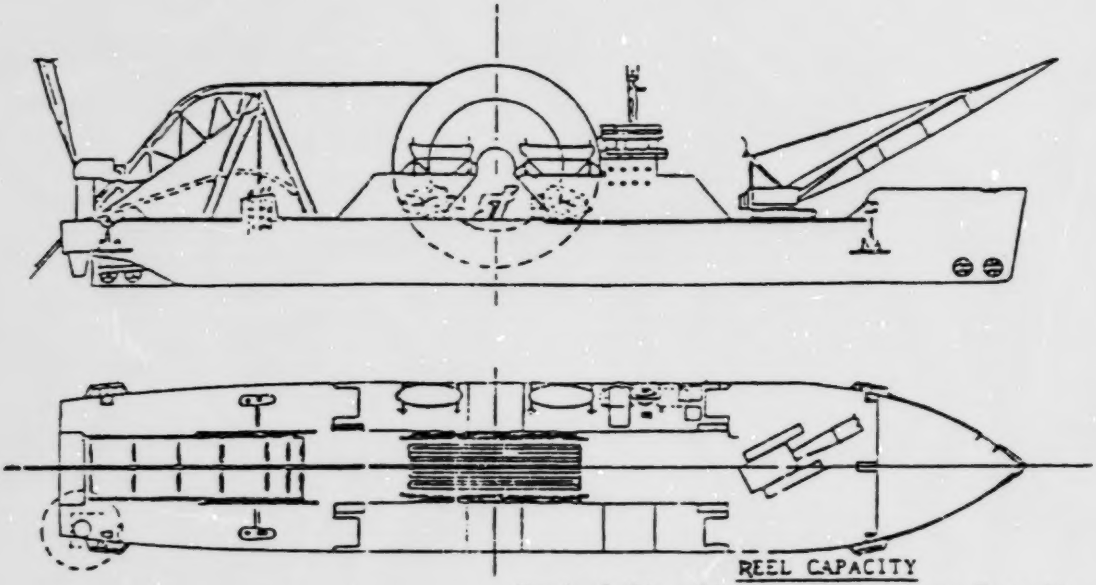
WESTCOAST TRANSMISSION COMPANY LIMITED	TYPICAL BOTTOM TOW CONFIGURATION
RJBA R. J. BROWN AND ASSOCIATES	

FIGURE 4


TENSIONER
RAMP ANGLE
WATER LINE
LAY BARGE
OVERBEND
STINGER
ANCHOR LINES
SAGBEND
SEA BOTTOM
TOUCH DOWN POINT

WESTCOAST TRANSMISSION COMPANY LIMITED	LAYBARGE
RJBA R. J. BROWN AND ASSOCIATES	

FIGURE 5



APACHE

Dynamically positioned pipelaying reel ship

REEL CAPACITY

Nominal Pipe Size (Inches)	Approximate Capacity (Feet)	(Miles)
4	267,000	50.5
6	160,000	30.3
8	104,000	19.7
10	73,000	13.8
12	54,000	10.2
14	45,000	8.5
16	30,000	5.7

WESTCOAST TRANSMISSION
COMPANY LIMITED

DYNAMICALLY POSITIONED
REEL SHIP 'APACHE'

RJBA
R. J. BROWN AND ASSOCIATES

Southern Route Options Proposed by B.C. Hydro

For the present application before the B.C. Utilities Commission, B.C. Hydro has elected to break the marine crossing into distinct areas; Roberts and Sturgeon Banks, Georgia Strait, and the Gulf Islands and marine channels. The alternate routings examined in these three areas are described below.

Roberts and Sturgeon Banks

Construction of a pipeline across the intertidal zone and foreslope of the Fraser Delta has long been recognized as one of the most environmentally sensitive tasks associated with a southern crossing of Georgia Strait. The banks are a refuge to millions of overwintering waterfowl, a habitat and migration route for hundreds of millions of salmon juveniles and adults, a feeding and breeding area for a large and commercially viable Dungeness crab population, and the recreational playground of the province's largest and most demanding urban centre (Vancouver). For these reasons, the banks are protected under the terms of provincial Order-in-Council 908 which requires a mandatory environmental impact assessment for any proposed work on the banks.

Three feasible pipeline routes were identified on the banks. These are identified in Figure 6. The first is an area located to the north of the Iona Jetty. Sturgeon Bank has a uniform slope of approximately 5° at this site. Soil conditions appear favourable and there is no evidence of past instability. South of the jetty the sewage flow from Iona Island is actively depositing sediment, an unsuitable substrate for pipeline support. Immediately south of the outfall, the bathymetric contours of the foreslope show many irregularities which are indicative of slumping, consequently this area was also considered undesirable.

The second feasible route is located immediately north of the Steveston Jetty. Here, the gradient and soil stability of Sturgeon Bank are again favourable to the installation of a buried pipeline. South of this route, off the main arm of the Fraser River, the foreslope is known to be unstable due to the rapid build-up and collapse of sediments.

The third route would require a crossing of Canoe Pass before crossing Roberts Bank. By crossing to the north of this channel, the pipeline would lie outside Canoe Pass' historic meander range. Any crossing of Roberts Bank to the south of Canoe Pass would not be favourable because of active deposition of river sediments, high voltage electrical cables, port development and the international boundary.

The major factors considered in selecting a preferred routing across the sensitive bank area were: pipeline reliability, pipeline cost, and environmental impact. For pipeline reliability the route must descend the foreslope in a stable area. Only two of the feasible routes fitted into this category: the first was north of Iona Jetty and the second due west of Brunswick Point. The Iona Jetty option was eliminated because the landward section would cross

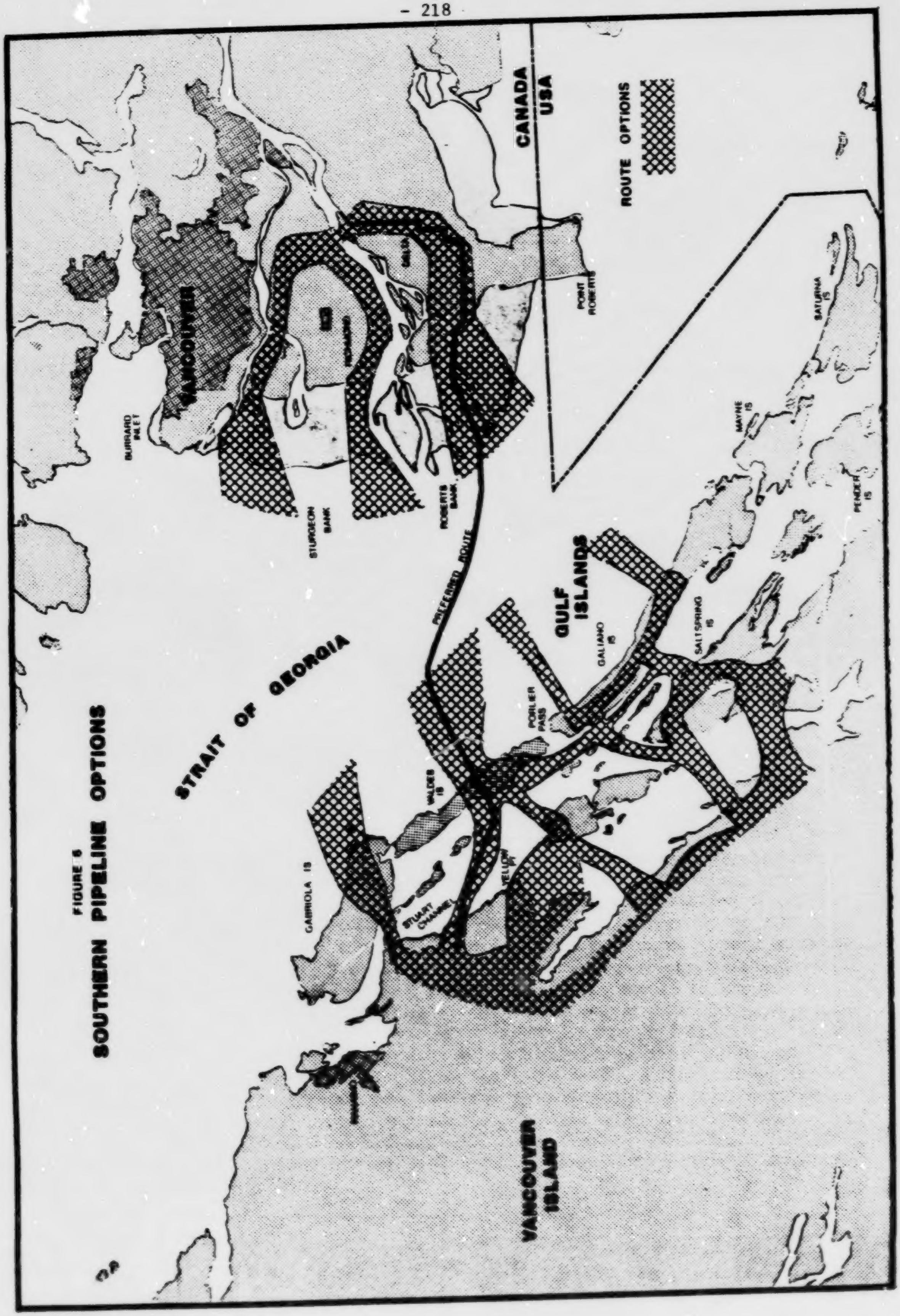


FIGURE 6
SOUTHERN PIPELINE OPTIONS

STRAIT OF GEORGIA
VANCOUVER
BURRARD INLET
STURGEON BANK
ROBERTS BANK
DELTA
POINT ROBERTS
CANADA
USA
ROUTE OPTIONS
PREFERRED ROUTE
GULF ISLANDS
GABRIOLA IS
VALDES IS
STUART CHANNEL
PORLIER PASS
GALIANO IS
SALTSPRING IS
PENDER IS
MAYNE IS
SATURNA IS
VANCOUVER ISLAND

heavily developed suburban areas resulting in high costs and increased social disruption. Environmental considerations did not influence the selection of the preferred route but did impact on construction sequence and timing.

Construction of dual high pressure (1440 psia) gas pipelines across an active delta the size of the Fraser, will involve innovative techniques. The geomorphology, surficial deposits, seismicity, liquefaction, wave and tidal action, influence of currents, channel scour and migration, winds, vessel traffic, thickness of pipe and depth of cover, are some of the physical constraints which had to be considered during initial planning and design of the project. In addition, the extensive spatial and temporal use of the bank area by salmonids, crabs, waterfowl and recreationists, had to dovetail into the planning and design to ensure that a construction methodology and schedule could be designed that would minimize the impacts on these resources. B.C. Hydro's prime consultant for this work, Monenco Pipeline Consultants, recommended the "bathtub" construction technique and adopted a landward construction sequence (versus seaward), starting at the foreslope of the delta during the summer months (August-September) and finishing by the end of February.

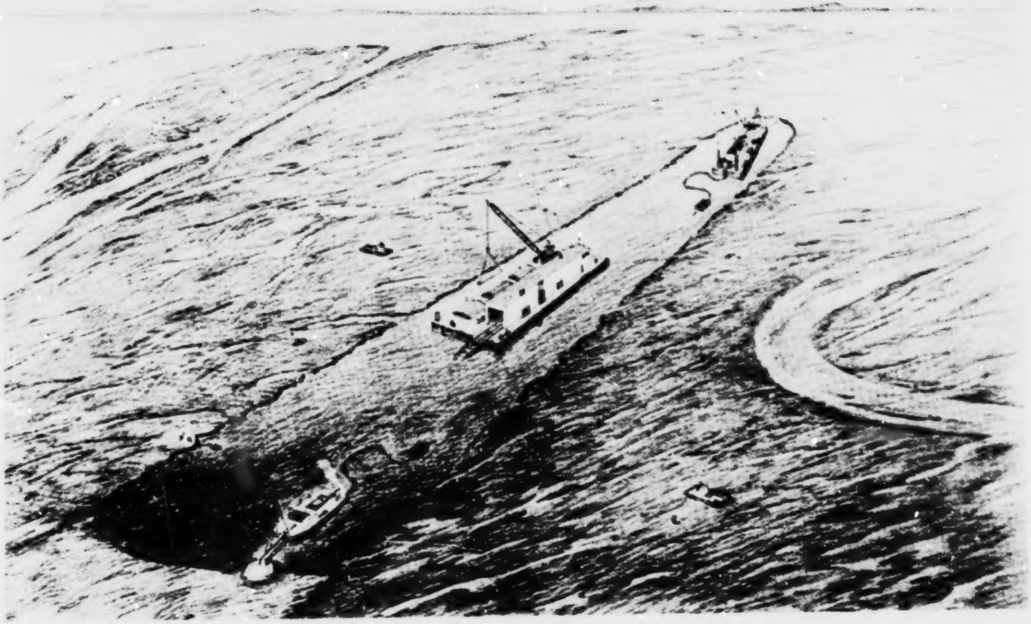
The "bathtub" would be of sufficient length to contain the cutter suction dredge, the shallow water laybarge, and a discharge pontoon (Figure 7). The minimum length of the train would be approximately 400m. It is intended that the dredge would start cutting the pipeline trenches at the head of the foreslope and move landwards. The commencement of this activity would require approval from Federal Fisheries (dependent upon the favourable results of a juvenile salmonid monitoring program conducted in the year of construction). As the dredge, laybarge and discharge pontoon progress toward Brunswick Point, the three vessels would float in their own "bathtub" when the banks are exposed at low tide. If B.C. Hydro is awarded a certificate, this will be the first time that this technique has been used to install a submarine pipeline anywhere in the world.

A landward construction sequence was selected primarily because the outer, more exposed foreslope work would be performed during the most favourable weather conditions, thus reducing accidents to crew and equipment and limited weather downtime. Either construction sequence will result in some impact on the benthic communities, crab populations, returning adult salmon, waterfowl feeding and loafing habitat, and public use (commercial fishing, marine traffic and recreation). B.C. Hydro estimates the crossing of Roberts Bank to take approximately six months.

Georgia Strait

Submarine conditions, existing B.C. Hydro buried cables, and the international boundary were the controlling factors determining the number of routes across southern Georgia Strait. Over 9 500 km of hydrographic surveys

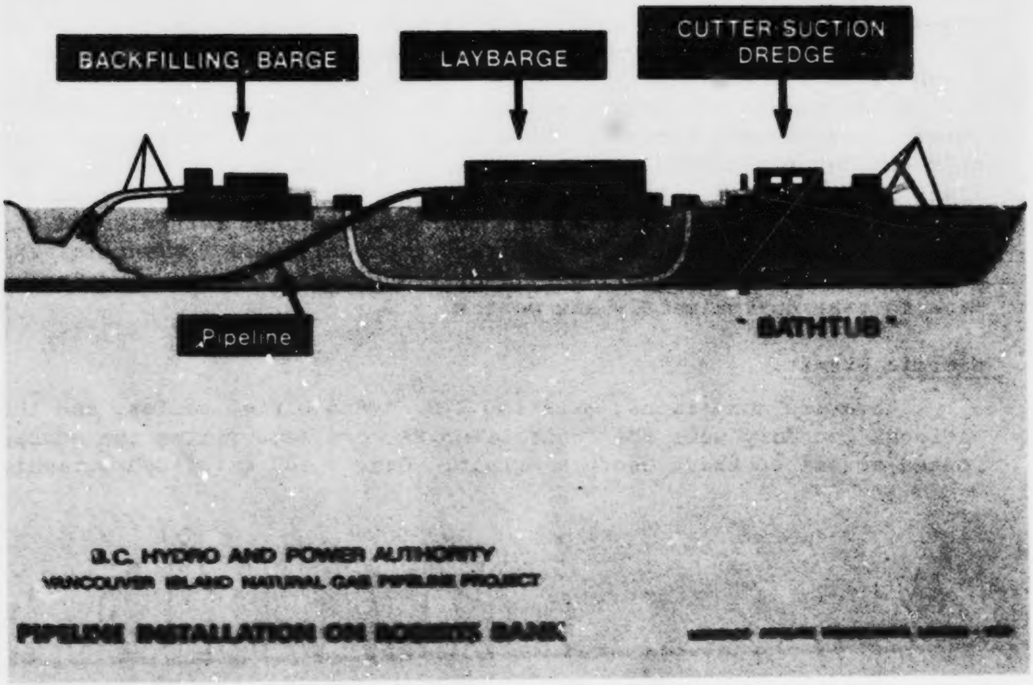
FIGURE 7



B.C. HYDRO AND POWER AUTHORITY

VANCOUVER ISLAND NATURAL GAS PIPELINE PROJECT

ROBERTS BANK CROSSING


BACKFILLING BARGE
LAYBARGE
CUTTER SUCTION DREDGE
Pipeline
"BATHTUB"

B.C. HYDRO AND POWER AUTHORITY

VANCOUVER ISLAND NATURAL GAS PIPELINE PROJECT

PIPELINE INSTALLATION ON ROBERTS BANK

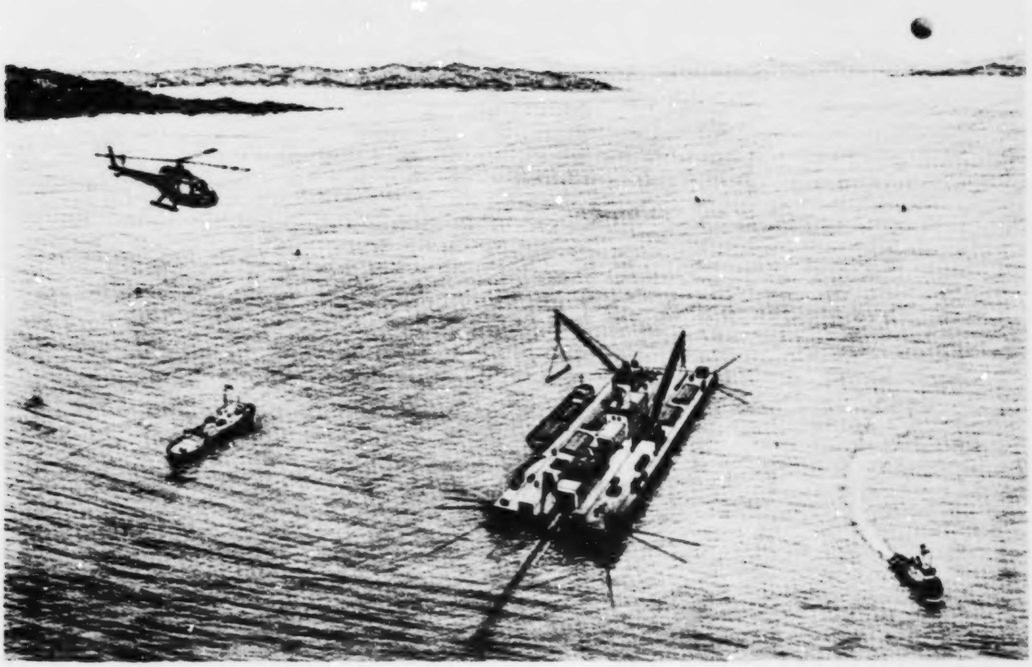
show that, within the area of interest, the seabed consists of the submerged portions of the Fraser delta in the east, thick sedimentary deposits in the deepest central portion of the Strait, and a series of rocky reefs on the western side. Two parallel submerged reefs extend along the north coast of Gabriola Island, and the east coasts of Valdes and Galiano Islands. The delta foreslope and the rocky ridges restricted the selection of possible routes across the Strait. The three potential routes across the delta banks and foreslopes lead to four feasible access points to the Gulf Islands. This route propagation is illustrated in Figure 6.

The submerged reefs on the east coast of the Gulf Islands presented major routing and design difficulties. Considerable profiling, soil sampling and drop ball testing preceded the identification of a passage through the reefs which could accommodate dual 406 mm pipelines spaced up to 120m apart, within the limits of pipe curvature and free spans, without resorting to manufactured pipe bends and significant modification of the seabed through blasting or deposition of fill. Two locations were identified where a pipeline could be laid following these criteria: the Valdes gap, and an area off-shore from Lantzville on Vancouver Island. The latter route was quickly discarded because of its increased length and the crossing of a Department of National Defence torpedo range. Two other options requiring seabed modification were located east of Galiano Island.

A series of parallel survey lines were run to establish topography of the seabed. Depth readings, using high resolution sonar, were tied into horizontal co-ordinates determined electronically from land-based shore stations. The system of sea bottom profiles were then properly positioned for contour plotting. The high resolution sonar profiles were also used to determine the presence of subsurface rock or marine sediments. In promising areas, the submersible "Pisces IV", was deployed to further investigate the bottom conditions. The results of this extensive work led to the adoption of a preferred underwater route which linked the preferred Fraser delta crossing, Valdes Gap and Valdes Island beachhead in a large sinusoidal curve.

The construction method proposed for the Strait crossing is different from that suggested for the shallow water work on Roberts Bank: in water depths over 20m, a deep water laybarge would be used. No dredging or backfilling of a trench is considered for this section of the crossing. An artist's rendering of the deep water laybarge operation is shown in Figure 8. Both the shallow water and deep water laybarge operate in the same fashion. Lengths of concrete-coated pipe are stored on racks on the laybarge. As the laybarge is winched forward on its anchor cables, each successive pipe length is lowered into place and processed through several working stations where they are welded together, x-rayed, and protectively wrapped. The welded pipe would then pass over the stern of the barge onto the overbend section of the

FIGURE 8



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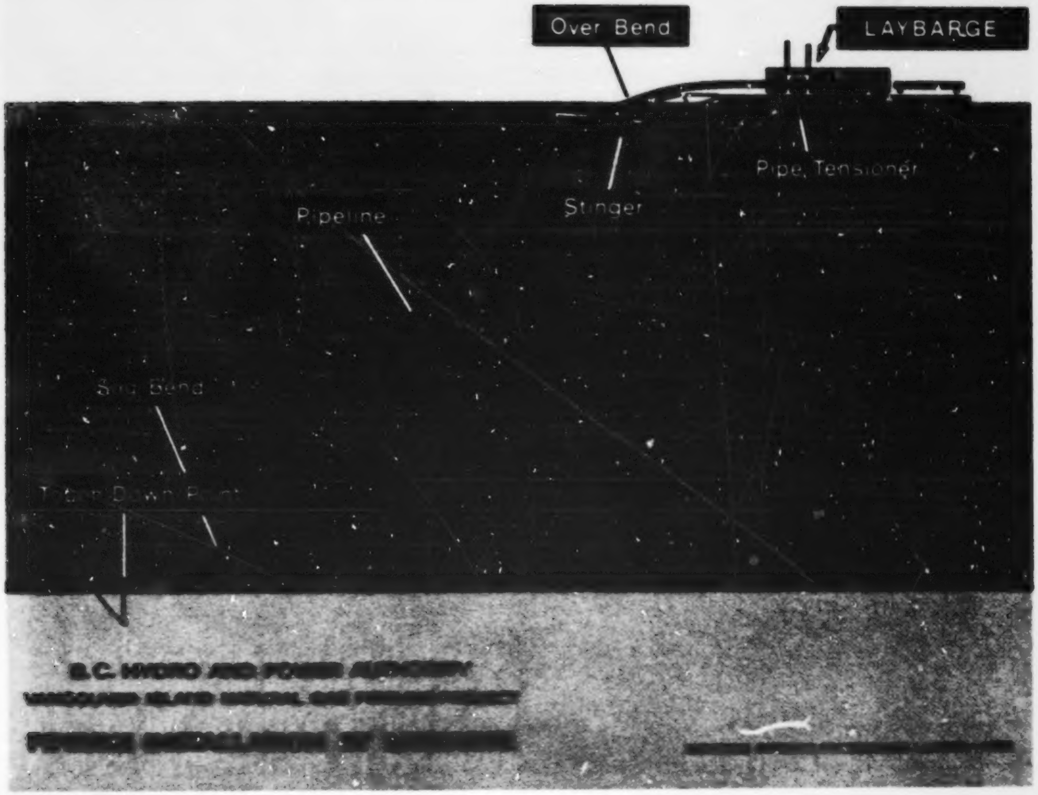
VANCOUVER ISLAND NATURAL GAS PIPELINE PROJECT

PIPELINE INSTALLATION BY LAYBARGE


Over Bend
LAYBARGE
Pipe Tensioner
Stinger
Pipeline
Sag Bend
Touch Down Point
B.C. HYDRO AND POWER AUTHORITY

long curved stinger. The suspended pipe would be kept in tension to prevent buckling at the sag bend as it is laid on the sea floor. This deep water laybarge operation would also be utilized for the crossing of Stuart and Trincomali channels. At the approaches to the beachheads the laybarge would be turned 180 degrees and the welded pipeline would be pulled along a prepared trench to the shoreline, using a winch positioned on the shore. Once completed, the seaward ends of the pipe would be lifted to the surface, welded together and dropped to the sea floor. It has been estimated that it would take three and one-half months to complete the installation of the dual submarine pipelines across Georgia Strait.

Gulf Islands and Marine Channels

After the four technically feasible access points to the Gulf Islands had been identified, routes connecting these to Vancouver Island were investigated. B.C. Hydro's hydrographic surveys of Stewart and Trincomali channels revealed three options to link Valdes Island to Vancouver Island that could be constructed using conventional construction methods. From Gabriola Island it is possible to construct a pipeline across Dodd Narrows to Vancouver Island, however, the currents in this area would necessitate an aerial crossing. From Galiano Island there are an additional two options, landing either at Chemainus Delta or the Saanich Peninsula and using various other Gulf Islands as stepping stones. In all, ten possible route combinations and two preferred options were identified (Figure 6). The major criteria for the selection of a preferred route from these options were: cost, reliability, land-use, fresh water sources, and the constraining influence of the "Islands Trust" a planning group with responsibility for development on the Gulf Islands. A weighted analysis reduced the possible routes to those utilizing sparsely populated Valdes and northern Galiano Islands. The Galiano north option was discarded because of higher cost, less reliability, and the preference expressed by Islands Trust for the Valdes Island route.

The three route options on Valdes Island were further reduced; two of them would require the installation of prefabricated bends, with reduced reliability. Therefore, the shortest route from Valdes Island to Vancouver Island, landing in the vicinity of Flewett Point, became the preferred route.

Construction of this portion of the dual submarine pipelines would follow that of the Georgia Strait crossing and would be conducted in a similar fashion using the deep water laybarge. Shore approaches would require the excavation of a common trench to a depth of 20m. The estimated time required for the second marine channel section would be three and one-half months.

Summary - Submarine Pipeline Routings

The total time required for B.C. Hydro's preferred submarine crossing from Brunswick Point to Flewett Point, including equipment mobilization and demobilization, is estimated at 19 months at a cost of $179 million ($1983). Westcoast's time allocation for the northern crossing from Powell River to Little River is seven and one-half months at a cost of $30.9 million ($1983). This cost and time difference is directly related to the pipe size difference (dual 406 mm pipelines versus dual 273 mm pipelines), length of the submarine crossings (53 km versus 32 km), construction technique (use of both a shallow water and deep water laybarge versus bottom tow), availability of equipment (foreign versus domestic), number of beachheads (four versus two) and difficulty of beachhead construction (rock and extensive Fraser Delta deposits versus gravel/sand beaches). One final point that should also be made is that the northern route would also connect the community of Powell River. An additional 32 km submarine crossing would be necessary if B.C. Hydro were to serve this market via the southern route.

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THE MARCY-SOUTH PROJECT
A HIGH-VOLTAGE TRANSMISSION LINE CROSSING OF THE HUDSON RIVER

James Nickerson and David Perry, Chas. T. Main, Inc.
Vincent Tobin, New York Power Authority

ABSTRACT

This paper addresses the complexities involved with the siting and licensing of a submarine high-voltage transmission line crossing of the Hudson River in New York State. The discussion covers (1) the structural options available; (2) the most important factors considered in selecting a satisfactory crossing site; (3) the roles and interactions of the utility, regulatory agencies, private organizations and local citizens; and (4) the final site and system configuration selected for this major river crossing.

INTRODUCTION

Increased regulatory and public concern focused on the ecological, social, cultural, and scenic attributes of water resources have impacted and are continuing to impact public and private utilities. For electric transmission facilities, this increase in regulation and expression of public concern has made crossing significant water resources with overhead lines more difficult and has resulted in more emphasis on underground and submarine methods of construction.

In 1980 the New York Power Authority (NYPA), in conjunction with the New York Power Pool, determined a need to reinforce the existing transmission system in New York State. A reinforced transmission system would allow for increased transfers of less expensive energy from upstate New York and the Provinces of Quebec and Ontario to southeastern New York. The increased capacity provided by a transmission reinforcement would also allow higher priced oil-fired generation located in southeastern New York to be displaced by more economical energy from New York and Canadian sources. The New York Power Authority estimated that at least 7.7 million barrels of oil could be saved annually once the proposed project was in place.

The firm of Chas. T. Main, Inc., was retained by the New York Power Authority to investigate the environmental and engineering feasibility of a new transmission line reinforcement between the vicinity of Marcy, New York and Poughkeepsie, New York as shown on Figure 1. The New York Power Authority's cross-state 345-kV lines extend from its Niagara Power Project to Marcy Substation, and its upstate 765-kV line extends from the Canadian border near the St. Lawrence-Franklin D. Roosevelt Power Project to Marcy. The proposed Marcy-South transmission facilities would constitute an extension of these facilities to the southeastern part of the state.

As shown on Figure 1, any transmission reinforcement from Marcy to Poughkeepsie would inevitably result in crossing the Hudson River. In the past, the Hudson River has shown itself to be a formidable environmental resource in utility-related projects including the Storm King Pumped Storage Project, Greene County Nuclear Power Plant, coal conversions and transmission lines. In assessing the feasibility of crossing this river, its importance as a cultural and natural resource was carefully considered. Equal attention was given to applicable regulations requiring compliance before construction could begin.

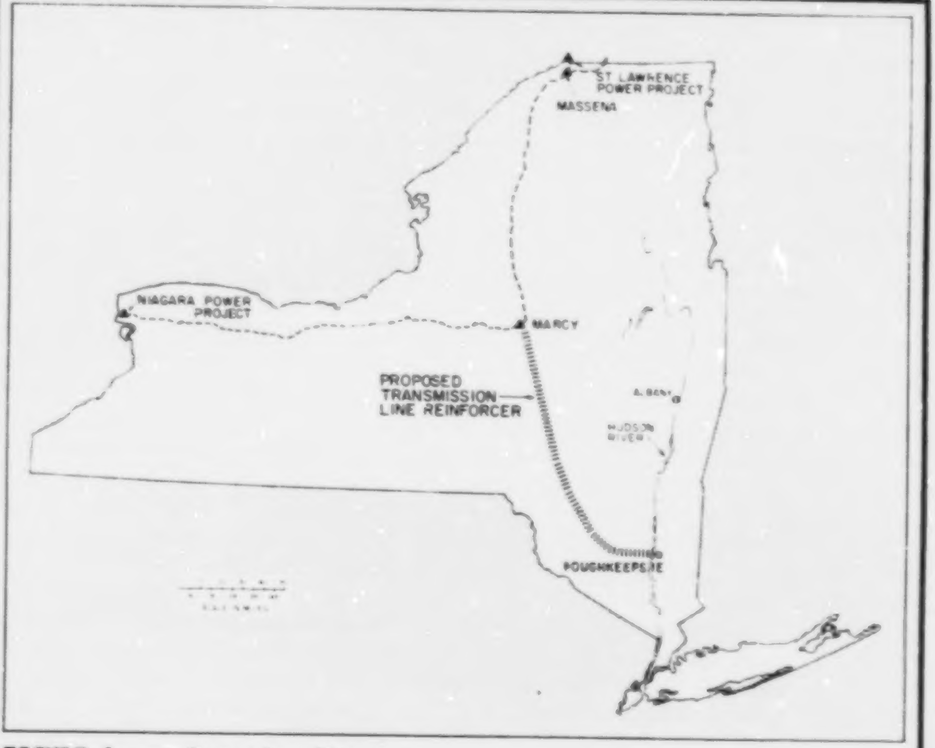


FIGURE 1 - Location Map

HISTORICAL, CULTURAL AND ECOLOGICAL SIGNIFICANCE OF THE HUDSON RIVER VALLEY

The historical, cultural, ecological and scenic resources of the Hudson River and its valley are of national significance. When Henry Hudson discovered the river in 1609, he named it "Great River of the Mountain." During the American Revolution the British repeatedly sought to control the Hudson River Gorge, the area from the Palisades near New York City, extending north 8 miles to the Hudson Highlands. Storm King Mountain and Breakneck Ridge mark the northern terminus of the gorge.

In 1775 on the gentle slopes of the valley Chancellor Robert Livingston and his nine brothers and sisters each established themselves in houses of great architectural variety and distinctive landscaping to govern their family holdings. Clermont was the Chancellor's residence. It was situated on the east shore and commanded a view of their 240,000 acres in the southern Catskill Mountains. The view across the river to the Catskills which was so enjoyed by the Livingstons became the focus of other great houses and estates built along the river during the 1800s by such notable families as the Roosevelts and Vanderbilts. This area in Dutchess and Columbia Counties is called the "Cradle of American Landscape Architecture," and much of the handiwork of Andrew Jackson Downing still exists.

As the 1800s progressed, tourism in the valley increased and resort hotels were built for those who came to view the scenery. Railroads built during the mid-1800s added further stimulus to tourism. Art, architecture and landscape architecture of this era embraced the romantic point of view. The influential Hudson River School of Painters was founded by Thomas Cole, and its members included such artists as Cropsey, Durand, Doughty, Kensett, Gifford and Church.

In the late 1800s citizens of New York and New Jersey became alarmed at the destruction wrought by quarrying in the Palisades. By 1900 both states had created commissions to "Save the Palisades." These efforts by the public culminated in the creation of major state parks (Pallisades, Bear Mountain and Hudson Highlands) to protect, preserve and enhance the character of the Hudson River. As part of an effort to provide New Yorkers with access to these choice parklands along the Hudson, the New York Commission bought and converted the steamships Clermont and Onteora to provide transportation.

In 1965 concern for the visual amenities of the Hudson River Valley was sparked by the proposed pumped storage hydroelectric plant affecting Storm King Mountain. This project was stalled and ultimately blocked as a result of environmental opposition. The New York State legislature, responding in part to the issues raised in the Storm King debate, created the Hudson River Valley Commission and directed the Commission to report by 1979 "with regard to the need to protect the scenic, recreational and ecologically important resources of certain designated areas of the Hudson River Valley...." The initial report in 1966, The Hudson, and the 1979 report, Hudson River Valley Study, have become landmarks in the evolving public concern for the visual and physical environment.

Essentially the Commission established a "Valley Visual Corridor" extending from the river to the ridges and crests of mountains. The corridor varied in width from less than a mile to six and more miles in certain locations, and extended some 300 miles from New York City.

The reports of the Commission dovetailed with other reflections of national environmental concern, such as the National Wild, Scenic and Recreational Rivers Act (affecting the Highlands) and the Coastal Zone Management Act of 1972 (the Hudson River is tidal to Albany). Among other things, the Commission sought to: clarify scenic easements; transfer development rights by municipalities to protect scenic, recreational and ecological resources; establish scenic roads; and create new waterfront recreational areas. Its two principal functions were to review all proposed developments within, and to prepare a comprehensive plan for the valley corridor. Although the Commission did not have veto power, through public hearings it was able to achieve project modifications by heightening public awareness and local government concern for aesthetics and land use decision-making.

In terms of ecology, the significance of the Hudson is well documented. The tidal portion of the Hudson River, which extends approximately 152 miles from the mouth of the river to Albany, is rich in ecological resources. A number of important sport and commercial fish are permanent or seasonal residents of the river. These fish include striped bass, American shad, white perch, largemouth bass, and many species of panfish. In addition, the shortnose sturgeon, a federally designated rare and endangered species, is present throughout the tidal portion of the river. Spawning and nursery areas for these fish occur in a variety of habitats along the river, including open river areas, mud flats within the river, tributaries to the river and marshes that abut the river. The New York State Department of Environmental Conservation has identified many of these areas as significant habitats.

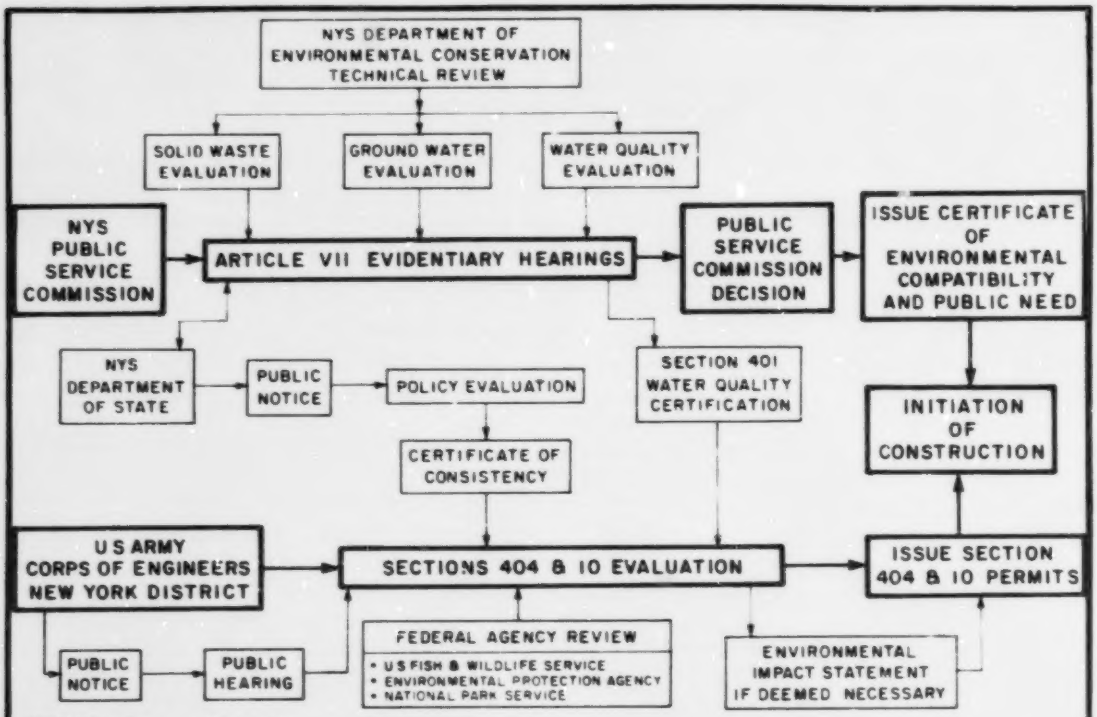
The well-publicized introduction of PCBs into the river has complicated its ecology because the resuspension of PCB-laden sediments could result in their uptake by fish in the river. Presently, a ban on commercial fishing for striped bass in the Hudson River exists because of unacceptably high PCB levels in the flesh of this species, although striped bass originating in the Hudson River still contribute substantially to the commercial and sport fishery in the waters off Long Island. The effort to protect habitat areas of this species has led to another well-publicized debate over a public project, the Westway highway project in New York City.

REGULATORY FRAMEWORK

Crossing the Hudson River with transmission facilities involves a number of major permit actions pursuant to several federal and state laws. The required approvals are primarily under the jurisdiction of the New York State Public Service Commission at the state level and the U.S. Army Corps of Engineers at the federal level. These two agencies provide the lead responsibilities in ensuring that the technical requirements of the various approaches are adequately addressed and ultimately implemented. Figure 2 shows the general relationship of the agencies involved in the approval process. The approvals required and agencies involved include:

Certificate of Environmental Compatibility and Public Need. This certificate requires that any proposed transmission line, including the Hudson River Crossing, be constructed in an environmentally compatible manner and be determined to be in the public need. The certificate, which is intended to provide for a comprehensive "one stop" licensing process for major electric transmission facilities, is issued by the New York State Public Service Commission after extensive evidentiary hearings.

Section 10 of the River and Harbor Act of 1899. This act governs any construction activity in navigable waters of the United States. The intent of this act is to maintain the integrity of navigable waterways for navigation. The U.S. Army Corps of Engineers has regulation responsibility.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SOLID WASTE EVALUATION
GROUND WATER EVALUATION
WATER QUALITY EVALUATION
NYS PUBLIC SERVICE COMMISSION
ARTICLE VII EVIDENTIARY HEARINGS
PUBLIC SERVICE COMMISSION DECISION
ISSUE CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY AND PUBLIC NEED
NYS DEPARTMENT OF STATE
PUBLIC NOTICE
POLICY EVALUATION
SECTION 401 WATER QUALITY CERTIFICATION
INITIATION OF CONSTRUCTION
CERTIFICATE OF CONSISTENCY
U S ARMY CORPS OF ENGINEERS NEW YORK DISTRICT
SECTIONS 404 & 10 EVALUATION
ISSUE SECTION 404 & 10 PERMITS
FEDERAL AGENCY REVIEW
• U S FISH & WILDLIFE SERVICE
• ENVIRONMENTAL PROTECTION AGENCY
• NATIONAL PARK SERVICE
PUBLIC NOTICE
PUBLIC HEARING
ENVIRONMENTAL IMPACT STATEMENT IF DEEMED NECESSARY

FIGURE 2 - Regulatory Process

Section 404 of the Federal Water Pollution Control Act Amendments of 1972. This act regulates the discharge of dredged or fill material in the waters of the United States. Its intent is to insure that chemical/biological integrity of water is protected. The U.S. Army Corps of Engineers has responsibility for issuance of permits pursuant to this statute.

National Environmental Policy Act of 1969. This act requires all federal agencies to consider the environmental impacts of "major federal actions." For the Marcy-South river crossing, the U.S. Army Corps of Engineers by virtue of its permit responsibilities discussed above, must assess to what extent, if any, the crossing will impact the environment.

Coastal Zone Management Act of 1972. This act is intended to encourage coastal states to manage their coastal resources in a prudent manner. Construction of major projects within the coastal zone must be consistent with the proper use and development of the zone. Responsibility for implementation of the requirements of this act and issuance of a Certificate of Consistency is delegated, under a federally approved coastal zone plan, to the State of New York, Department of State.

Section 401 of the Federal Water Pollution Control Act. This statutory provision requires certification by the state that any proposed discharge into a navigable waterway will not contravene state water quality standards. Although responsibility for issuance of the water quality certificate is normally delegated to the New York State Department of Environmental Conservation, in the case of electric transmission lines, it is conferred upon the State of New York Public Service Commission. The U.S. Army Corps of Engineers cannot issue a Section 404 or Section 10 permit until a 401 Certificate is granted.

New York Code of Rules and Regulations (NYCRR) Facility Criteria; Part 360. This regulation applies to the design and operation of solid waste management facilities in the State of New York, including in part those designated for dredged material. The New York State Department of Environmental Conservation is normally the implementing agency for the Part 360 regulations; however under the New York Public Service Law, the New York State Public Service Commissfon assumes that responsibility for electric transmission lines.

State Pollutant Discharge Elimination System Permit. This permit requires that a proposed discharge shall not contravene the water quality standards as established by the New York State Environmental Conservation Law. Again, in the case of electric transmission lines, this is the responsibility of the New York Public Service Commission.

SELECTION OF THE CROSSING LOCATION AND CONFIGURATION

The study area for the siting of the proposed 345-kV line between Marcy and Poughkeepsie included a 17-county area covering about 1,500 square miles in southeastern New York. The Hudson River study area extended from the vicinity of the Town of Beacon, Putnam County New York to the City of Albany approximately 90 miles to the north. The analysis of this area and potential river crossings included not only the river proper, but the approach areas as well, resulting in a Hudson River study area which varied in width as shown on Figure 3. The importance of the river and its resources significantly influenced both the locations and types of transmission line crossings considered for the Hudson River.

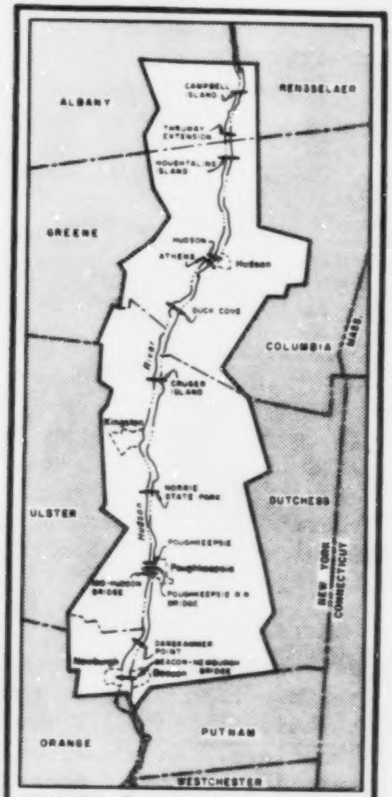
CAMPBELL ISLAND
RENSSELAER
ALBANY
THRUWAY EXTENSION
HOUGHTALING ISLAND
GREENE
HUDSON
ATHENS
Hudson
DUCK COVE
COLUMBIA
MASS
River
CRUGER ISLAND
Kingston
NORRIE STATE PARK
DUTCHESS
ULSTER
Hudson
POUGHKEEPSIE
Poughkeepsie
MID-HUDSON BRIDGE
POUGHKEEPSIE R.R. BRIDGE
NEW YORK
CONNECTICUT
DANSKAMMER POINT
Newburgh
BEACON-NEWBURGH BRIDGE
Beacon
ORANGE
PUTNAM
WESTCHESTER

FIGURE 3 - Hudson River Study Area

The first step in selecting a crossing site and method of crossing was the identification and mapping of routing opportunities and constraints. Routing opportunities, or areas most suitable for the location of a transmission facility, include both used and vacant existing rights-of-way. Routing constraints, or areas to avoid, were identified on the basis of potential for impact, agency/public concerns and past experience with similar facilities. These constraints included the following:

- Significant fish, wildlife, and plant habitats; wildlife management areas; protected natural areas; and endangered, threatened or rare species habitat;
- Spawning areas and nursery grounds of shad, striped bass and shortnose sturgeon;
- Designated scenic areas such as the limestone cliffs and the Hudson Lighthouse;
- Historic sites, districts, and archaeological sites included in the National Register of Historic Places such as the Roosevelt and Vanderbilt estates;
- Existing land uses including cities, towns, villages, parks, and public lands;
- Prime farmland, active croplands and agricultural districts;
- Planned land uses from comprehensive plans and master plans;
- Areas of high scenic quality.

Such areas were documented on overlays and used as a basis for locating potential approach routes and selecting crossing sites.

In conjunction with mapping, criteria were also established for both overhead and submarine crossings. In identifying potential sites for overhead crossings, only those areas with existing overhead crossings or those areas where structures would not be required in the river were considered. Two locations were determined to be suitable for an overhead crossing. These included the Berkshire (Thruway) Extension Bridge southeast of Albany, and an existing 345-kV crossing near Athens.

For potential submarine crossing sites, existing access to both sides of the river was a requirement. Terrestrial and aquatic resources, and geotechnical conditions were also primary determinants for selecting crossing locations. As shown on Figure 3, six potential submarine crossing sites were identified: Houghtaling Island, Hudson, Duck Cove, Poughkeepsie, Danskammer Point, and Norrie State Park. In addition, through preliminary discussions with utilities whose franchise areas include portions of the Hudson River Valley, two possible crossing sites with existing rights-of-way on both shores were identified: Campbell Island, suitable for an overhead crossing and Cruger Island, suitable for a submarine crossing.

As the study progressed, three additional crossing sites were considered. Each involved use of an existing bridge across the Hudson River. These sites included: the Mid-Hudson Bridge, Poughkeepsie Railroad Bridge and Beacon Newburgh Bridge. As a result of this study, nine locations for submarine crossings, three locations for overhead crossings and three bridge crossings were identified. Sites which received the greatest attention involved three very different modes for crossing the river. These sites included the following:

Berkshire (Thruway) Extension Bridge Site: Three crossing structures are located at this site southeast of Albany: a highway bridge (Berkshire Extension of N.Y.S. Thruway); an active railroad bridge; an existing steel pole H-frame 345/765-kV crossing of the Hudson River (Figure 4). Because of the existing crossing structures and the relatively narrow width of the river, it was determined that this was an appropriate location for an overhead crossing. To minimize further impacts in this area, the New York Power Authority proposed to parallel existing transmission corridors to the river and to use structures very similar to those already spanning the Hudson. However, for a variety of reasons the alternate corridor utilizing this crossing was ultimately dropped.

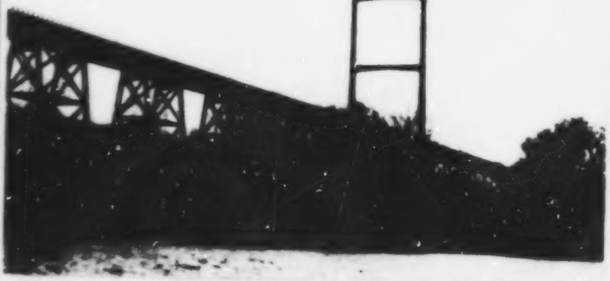

FIGURE 4 - Berkshire (Thruway) Extension Bridge Site

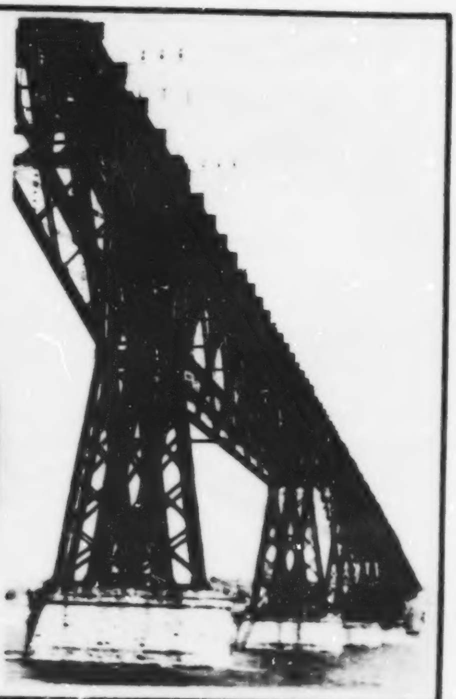

FIGURE 5 - Poughkeepsie Railroad Bridge

Poughkeepsie Railroad Bridge: Of the several bridges considered in detail, a crossing utilizing the Poughkeepsie Railroad Bridge appeared to be the most feasible. The bridge, a National Register Historic Site, was built between 1871 and 1888. It was the first structure of this size in the

United States to use steel rivet construction (Figure 5). The bridge was an attractive site for a possible transmission line crossing since it is not actively used; it presently carries a 115-kV transmission line; and, through an independent analysis by a bridge consultant, it was determined to be capable of carrying the proposed 345-kV circuits. One disadvantage of using the bridge was the need to develop a method of crossing that would not alter its appearance. In addition, extensive commercial, industrial, and residential development on both sides of the river in this area created substantial constraints and potential for impacts related to routing of two 345-kV circuits to and from the river, whether overhead or underground. Other disadvantages included its higher cost and fewer electrical system benefits as compared with the Danskammer Point site.

FIGURE 6 - Danskammer Point Site

Danskammer Point Site: Of the many locations considered for crossing the Hudson River, the Danskammer Point area seemed most appropriate. Power plants already exist on the west shore, and an emergency pumping station and intake facility which are part of New York City's water system are located on the east shore. On both sides existing transmission corridors proceed to the shore of the river. No ecological constraints were identified within the river itself, nor were any significant cultural features found at the site or in close proximity. However, even though the crossing area was without significant constraints, it was determined that utilizing the required 400 to 450-foot overhead crossing structures would be inappropriate because of aesthetic impacts to the river, surrounding developed areas and nearby sites of high cultural significance.

While some sites received more detailed analysis than others, each of the sites and approach routes was evaluated for a range of environmental and engineering factors. Characteristics of each site are shown on Figure 7, below. This analysis led to the selection of the Danskammer Point site as the preferred location for the proposed transmission line crossing.

	TYPE OF CROSSING	NEW OVERHEAD CORRIDOR (mi)	NEW UNDERGROUND CORRIDOR (mi)	RIVER CROSSING (ft)	VACANT RIGHT-OF-WAY AVAILABLE	SLOPES	ACCESS	LAY DOWN AREAS	LAND USE	AQUATIC HABITAT SENSITIVITY	VISUAL IMPACT	ENGINEERING FEASIBILITY	ENVIRONMENTAL FEASIBILITY
CAMPBELL ISLAND	OVERHEAD	16.1	NONE	1700'	YES	MODERATE	GOOD	FAIR	WOODED/ RURAL	HIGH	HIGH	MODERATE	MODERATE
BERKSHIRE EXT. BRIDGE	OVERHEAD	NONE	NONE	1500'	PARTIAL	STEEP	FAIR	FAIR	RESIDENTIAL/ RURAL	MODERATE	LOW	HIGH	MODERATE
HOUGHTALING ISLAND	SUBMARINE	3.0	1.0	2500'	NO	STEEP	POOR	POOR	WOODED/ RESIDENTIAL	HIGH	MODERATE	LOW	LOW
HUDSON	SUBMARINE	2.5	3.3	2800'	NO	GENTLE	GOOD	GOOD	INDUSTRIAL/ RURAL	MODERATE	LOW	MODERATE	LOW
ATHENS	OVERHEAD	NONE	NONE	3000'	NO	STEEP	GOOD	FAIR	RURAL	LOW	HIGH	HIGH	LOW
DUCK COVE	SUBMARINE	8.0	0.8	5600'	NO	STEEP	FAIR	POOR	INDUSTRIAL	MODERATE	MODERATE	LOW	LOW
CRUGER ISLAND	SUBMARINE	13.0	3.0	3800'	YES	GENTLE	FAIR	GOOD	WOODED/ RURAL	HIGH	MODERATE	MODERATE	LOW
NORRIE STATE PARK	SUBMARINE	6.5	0.9	4200'	NO	STEEP	POOR	POOR	WOODED/ RURAL	HIGH	HIGH	LOW	LOW
POUGHKEEPSIE	SUBMARINE	10.0	3.0	2800'	NO	STEEP	FAIR	FAIR	COMMERCIAL/ INDUSTRIAL	LOW	MODERATE	MODERATE	MODERATE
RAILROAD BRIDGE	BRIDGE	10.9	3.5	2500'	PARTIAL	NA	GOOD	GOOD	COMMERCIAL/ RESIDENTIAL	NONE	LOW	MODERATE	MODERATE
MID HUDSON BRIDGE	BRIDGE	11.0	4.0	2200'	NO	NA	POOR	POOR	URBAN CENTER	NONE	LOW	NOT FEASIBLE	LOW
DANSKAMMER POINT	SUBMARNIE	6.5	0.2	3500'	YES	STEEP	GOOD	GOOD	INDUSTRIAL	LOW	MODERATE	HIGH	HIGH
BEACON-NEWBURGH BRIDGE	BRIDGE	17.0	6.0	5600'	NO	NA	POOR	POOR	COMMERCIAL/ RESIDENTIAL	NONE	HIGH	MODERATE	LOW

FIGURE 7 - Site Characteristic Matrix

DANSKAMMER POINT DETAILED STUDIES

To obtain the required approvals described previously, detailed engineering and environmental studies of the proposed underground/submarine system were undertaken at the Danskammer Point Site.

Engineering Concept

The New York Power Authority's plan involves the installation of buried pipe-type cable across the Hudson River. Meeting the thermal requirements for anticipated normal load on this circuit will require five 345-kV oil-filled pipe-type cables. Each cable will consist of 3-single phase 2,500,000 circular mil segmented copper conductors. To minimize the possibility of a long-term outage in the event that a cable failure occurs, a sixth pipe-type cable (spare) will be installed.

Design and construction of the proposed cable crossing involves three distinct segments -- the river, the east shore and the west shore. The submarine portion of the crossing is about 3,500 feet in length and will require the excavation of a trench in the river bed approximately 155 feet wide at the top, 45 feet at the bottom and 6 feet deep. Due to a number of factors, including the depth of the river (± 60 feet), it was determined that a clamshell dredge should be used to remove an estimated 80,000 to 85,000 cubic yards of material from the trench. Once the trench is open, the pipe-type cables will be laid in sections approximately 8 feet on center and then covered with a clean thermal backfill to the original contour of the river bottom. From the west shore of the river to a transition station (approximately 100 feet), the facilities will be installed in three separate trenches, 6 feet wide by 5 feet deep. The transition station will include a triple manhole for splicing of the cables, pipe cable potheads, station busswork, pumping plants, cathodic protection, annunciation and communication equipment, and station bridges for connection to the overhead circuit. Also, because of the potential for flooding on this side of the river, the site for this transition station will be filled to an elevation above the 100-year flood level. A general plan view of the land and river portions of the underground/submarine cable installation between transition stations is shown on Figure 8.

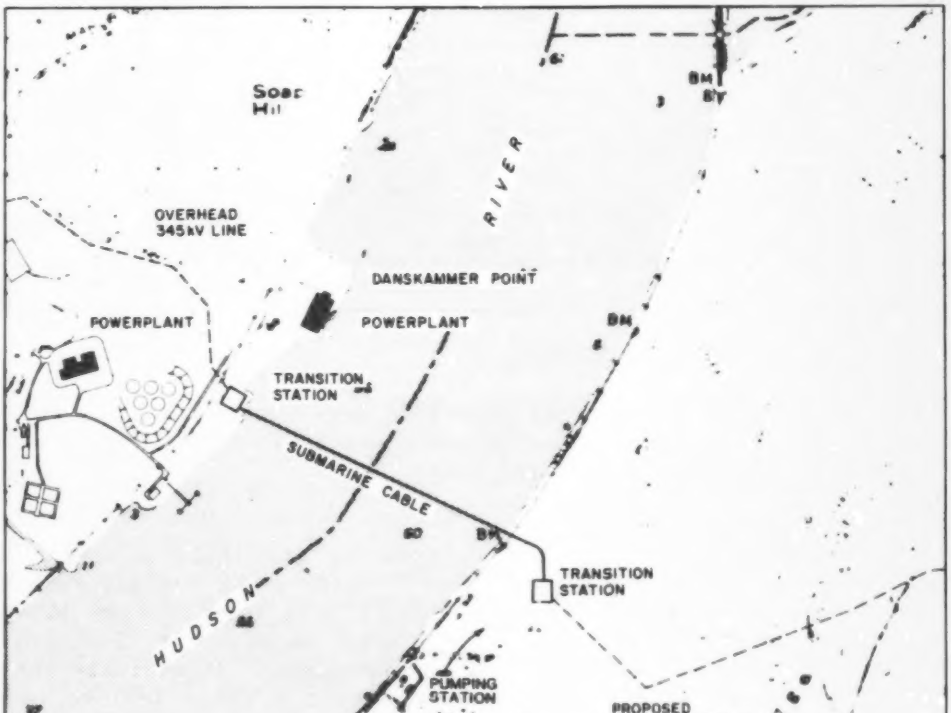
OVERHEAD 345kV LINE
RIVER
DANSKAMMER POINT
POWERPLANT
POWERPLANT
TRANSITION STATION
SUBMARINE CABLE
TRANSITION STATION
HUDSON
PUMPING STATION
PROPOSED OVERHEAD 345kV LINE
BM
BM
BM
BM
60

FIGURE 8 - Plan View of River Crossing

Whereas the west shore is relatively flat, mostly open and easily accessible, the east shore has very steep wooded topography and two active railroad tracks, significantly adding to the complexity and difficulty of design and construction. On exiting the river on the east shore, the pipes will cross under the two rail tracks and enter a triple manhole. The underground installation will consist of three separate trenches 6 feet wide by 5 feet deep with two cables in each. Construction at the east shore of the Hudson River will require temporary cofferdams to establish a work area for installation of sleeves underneath the railroad tracks. Approximately 900 feet away at a second transition station similar to the west shore station, the facilities will return to overhead construction.

Geotechnical and Biological Site Investigation

A soils investigation program was conducted to determine the feasibility of crossing the river with a buried submarine cable. Ten land borings and nine river borings were drilled. Soil sampling included Soil Penetration Tests, classification of undisturbed sampling and rock coring. Soil investigation was necessary because of the silty clay nature of the river sediment and potential for pipe settlement. The analyses indicated that while some settlement will occur it would not affect the feasibility of the submarine crossing. The bioassay and chemical analyses were carried out on sediments from each river boring location at 6 and 12-foot depths. The analyses were undertaken to provide basic data influencing the selection of a method of dredged material disposal. This analysis focused on the potential presence of PCBs and heavy metals as areas of concern.

Aesthetic Assessment

Of the many considerations associated with crossing the Hudson River, potential visual impacts or impacts on the aesthetic quality of the river were of primary concern. The major components of the project to be considered in connection with these concerns included the transition stations, trenches traversing the steep slopes on the east shore and the overhead lines proceeding from the transition stations. Analysis of this area included extensive field investigations, cross-section analysis and simulations to determine the most effective means of minimizing potential visual impact.

On the west shore the presence of existing power plants and transmission lines greatly reduced potential visual impact. However, in siting the new facilities, existing transmission lines were paralleled where practical and existing topography was utilized to backdrop the required overhead line. To minimize the visual impact of the transition station on the west shore an extensive planting program of indigenous trees and shrubs has been planned to screen the facility. In addition, limitations were placed on the size of the structural members within the transition station.

On the east shore, extensive studies were made of the proposed facilities and as a result it was determined that the transition station should be located on a hillside several hundred feet from the shore. In this location, existing vegetation and topography would either screen or backdrop the entire station. The cable route was assessed in terms of alignment and restoration potential. The route ultimately selected as shown on Figure 8 was angled to prevent views from the river directly to the station. Then a conceptual planting plan was developed utilizing indigenous trees and shrubs to blend the required right-of-way and areas disturbed during construction with the wooded hillside.

To minimize the visual impact of the transmission structures leaving the transition station, a steel pole H-frame design was selected. This design minimizes the heights needed for electrical clearance and is compatible with existing wood pole H-frame structures. Also the route for these lines was selected to effectively utilize existing topography and vegetation to screen and/or backdrop the structures.

Based on the proposal for these facilities as now refined by events during the New York Public Service Commission hearing process, this crossing will be accomplished in a manner resulting in minimum visual impact to local residents and travelers on the Hudson River.

East Bank Restoration

Because of severe topography and potential for scarring, erosion and sedimentation, restoration of the east shore was identified early on as an area of concern in the design and construction of the proposed submarine/underground facility.

In designing the facility, a concerted effort was made to minimize that portion of the east shore cleared, graded, or otherwise disturbed for construction. Where feasible the conceptual construction plan utilized existing topography and access to minimize disruption to the steep slopes and shore. A comprehensive erosion and sedimentation control plan including interceptor ditches and sediment ponds was developed to contain construction impacts to the smallest area practicable. Finally, a planting plan was developed utilizing indigenous trees, shrubs and ground covers to stabilize the area and to blend the construction and project facilities area with adjacent natural areas.

Although also important in terms of restoration, the west shore was less of a problem because of the relatively easy access, flat slopes and extent of the existing development.

Dredged Material Disposal

As indicated above, approximately 85,000 cubic yards of material will be dredged from the Hudson River. Initially both ocean and upland disposal were considered for this material. Both methods of disposal were evaluated to determine which was the most feasible alternative. Evaluation of ocean disposal on the basis of environmental, technical and cost factors indicated that it is a feasible method. Also, analysis and evaluation of sediments indicated that the dredged material meets the New York District of the Corps of Engineers requirements for ocean disposal. However, ocean disposal is becoming increasingly unacceptable from a regulatory point of view in the United States. Rather than risk delays in construction as a result of potential regulatory problems, NYPA elected to proceed with an upland disposal concept. For the evaluation of upland disposal sites it was necessary to identify potential sites and evaluate each site on the basis of environmental compatibility, technical feasibility, and cost.

From an original selection of 58 potential upland sites, ten candidate sites were identified for further study. These candidate sites were evaluated on many factors including: accessibility, proximity to developed areas, aquatic features, terrestrial habitat, topography, aesthetics, and existing and planned land use.

Based on that evaluation, two sites were selected for comprehensive analysis. As part of this further evaluation, site plans depicting off-loading and storage areas were developed for each site. On the basis of these site plans and considering the logistics and estimated costs of dredging and barging the material to the proposed site, a final site was selected.

The selected site is located 27 miles upriver of the river crossing and is a former brick yard. Prime factors in selecting this 94-acre site included the industrial nature of the area, proximity to the main shipping channel, deep impermeable clay layer, and lack of conflicting surrounding land uses. The engineering concept for the site involves the construction of an off-loading area for tie-up of barges and tugs. The material would be moved by means of a pumping station and a pipeline to an impoundment area. A pneumatic pump system was selected to transfer the dredged material from the transport barge to the upland disposal site. This system which uses a pneumatic/hydro-positive displacement principle allows for handling a higher percentage of solids than comparable hydraulic dredge systems. The impoundment area would include a spillway, sedimentation basin and standpipe overflow. The concept involves a spillway designed to discharge the excess flow from a 100-year, 6-hour storm. The surface area of the impoundment is approximately 12 acres.

It is anticipated that after its use as a disposal site, this area can be restored for public use including public access to the river for boating and other recreational activities.

PROGRESS OF SITING AND LICENSING PROCESS

On November 18, 1982 the New York Power Authority filed its detailed Application for a Certificate of Environmental Compatibility and Public Need for the Marcy-South Project, a document which summarized the extensive environmental review undertaken for the project, with the New York State Public Service Commission. On December 15, 1982, the Power Authority made its initial filing for Section 404 and Section 10 Permits with the New York District of the U.S. Army Corps of Engineers. These filings began a licensing process that is still continuing today. At the time of filing the licensing process was estimated to take approximately two years and allow for initiation of construction on December 1, 1984. As shown on

Figure 2, the New York State Public Service Commission is the focal point for state approvals as is the U.S. Army Corps of Engineers at the federal level.

State Process

At the state level it was estimated that hearings before Administrative Law Judges would last fourteen months. The process began on January 4, 1983 when 35 statutory and intervenor parties made known their intent to be active participants in the state procedure. Parties included those whose participation is required by state law such as the New York Department of Environmental Conservation, New York Department of Agriculture and Markets, New York Department of State and voluntary intervenor parties such as Scenic Hudson, Prudent Residents opposed to Electric Cable Transmission (PROTECT), Delaware County Citizens Opposing Power Lines, Hudson Valley Green and Friends of PROTECT.

Prior to evidentiary hearings which began on April 17, 1983, six public statement hearings were held along the length of the proposed line. Attendance at most of the meetings ranged from 100 to 800 people. Evidentiary hearings were completed on February 3, 1984, after more than 12,000 pages of transcripts had been produced. With respect to the Hudson River crossing, the New York Power Authority through its consultant Chas. T. Main, presented witnesses in areas pertaining to visual impacts, aquatic impacts, land use, sediment toxicity, engineering feasibility and construction. Hudson River topics of concern in the hearings centered on the addition of another utility facility in an area considered as a natural resource of state significance; visibility of the transition stations and overhead approach routes as viewed from the river; potential toxicity of the dielectric fluid to be used in the cable pipes; change in water temperature; possible PCB sediment contamination; restoration and landscaping of the east and west banks; methods of sediment disposal; discharges from the upland disposal site; monitoring of dredged sediments; and overhead river crossing options.

Prior to and during the hearing phase NYPA worked with agencies as well as private intervenors such as Scenic Hudson to answer questions, develop supplemental information and accommodate suggestions and additional requirements into its proposed method of crossing and dredged material disposal.

The state proceeding is now in the briefing phase where written arguments are made to the Administrative Law Judges supporting or opposing certification of the NYPA's proposal and granting of certificates related to water quality (Section 401), solid waste disposal (Part 360), and water quality (SPDES). Through the efforts undertaken to date in the selection of the proposed site, adoption of a submarine crossing configuration, and a constant willingness to work with agencies and organizations with responsibilities and concerns related to the Hudson River, NYPA to a large degree has minimized opposition to the crossing. This is best exemplified by direct testimony of agency and private organization witnesses which presented no unresolved Hudson River issues.

Federal Process

At the federal level, subsequent to receiving NYPA's Application in December of 1982, the Corps of Engineers requested and reviewed supplemental data over a 12-month period extending until December 1983. On December 5, 1983 a Public Notice was issued by the Corps requesting public comment on the proposed facility across the Hudson River and proposed upland disposal site. Of the 117 letters responding to this Public Notice, 66 of them were supportive of the project, 43 (including three petitions with approximately 1,000 signatures) requested a public hearing and the preparation of an Environmental Impact Statement (EIS), and eight requested additional clarification of various project activities. For the most part, state and federal legislators, executive officers of large companies and other business-related organizations were in favor of the project. Opponents included primarily private citizens from locally affected areas who perceived the entire project to be unnecessary and environmentally unacceptable. Twenty responses came from parties who have been involved in the proceedings at the state level hearings. Typical concerns expressed in these letters included visual impacts at the river crossing, the timing of dredge and fill activities, sediment quality, the local impact of constructing and operating the upland disposal site, and some general concerns related to the transmission line project as a whole. Each of these concerns was noted and specifically addressed in a detailed response filed by the New York Power Authority to the Corps of Engineers.

Currently, the Corps of Engineers is carrying out its own environmental assessment as a basis for deciding to (1) issue a Section 404 Permit or (2) require an EIS. If it is determined that an EIS is not needed and a Section 401 certificate is received, a permit can be granted within 90 days of such a determination. If an EIS on the entire project is determined to be necessary, as much as 24 to 30 months may be required before a Final Environmental Impact Statement is prepared.

The other mandatory approval required by the Corps of Engineers prior to issuance of a Section 404 permit is a Certificate of Consistency with the State Coastal Zone Management Program. On June 1, 1983 an application was filed with the New York Department of State for a determination that the proposed NYPA facilities would be consistent with the state plan. In evaluating the application the state considers 44 policies under the plan with which each proposal must show consistency. These include policies such as discharge of excess nutrients, organics and eroded soils into coastal waters; conducting dredging and dredge spoil disposal in a manner which will protect significant fish and wildlife habitats, scenic resources, natural protective features and wetlands; protection of fish and wildlife resources from hazardous waste and other pollutants; and erosion. The New York Department of State issued a Public Notice on November 9, 1983 and based on the comment period and its own evaluation issued a Certificate of Consistency on December 5, 1983.

Those at the New York Power Authority and Chas. T. Main, Inc., who have worked on this project since 1979, believe that the willingness to forthrightly consider the range of social, cultural, ecological and engineering aspects of a major river crossing such as the Hudson River has led to the success of the licensing process to date. It is anticipated that all required permits for construction of the crossing may be in place in accordance with the original 24-month period originally estimated and that the facility can be placed in service ahead of schedule. Although crossing the Hudson River has been an extremely complex and potentially controversial aspect of this project, early consideration of all environmental and licensing requirements has proved successful in moving toward completion of of the Marcy-South line.

ARCTIC MARINE TRANSPORT: AN EXAMPLE OF INTEGRATED ROUTE ANALYSIS

MICHAEL R. ROBERTSON, PETRO-CANADA RESOURCES
PETER WOOD, PETRO-CANADA RESOURCES

INTRODUCTION

The Arctic Pilot Project (APP) was designed to test the feasibility of producing natural gas from fields on northern Melville Island (NWT), transporting the gas by pipeline across the island, liquefying the gas and then shipping the LNG south throughout the year by two icebreaking carriers. The focus of this paper is the marine transportation corridor that was delineated by APP for year-round marine use.

The basic requirement of the marine transportation component of the project was to deliver 62 billion m^3 of natural gas over a twenty year production phase. The environmental policy of the company stated that the project was to be operated in a manner that minimized environmental impact. To ensure that ship routing would adhere to this policy a multidisciplinary team completed an Integrated Route Analysis and delineated a corridor in which the APP vessels would operate. The team identified three broad areas that required analysis and integration: public and ship safety, environmental and social concerns, and economics.

BACKGROUND AND OBJECTIVES OF THE INTEGRATED ROUTE ANALYSIS

Prior to the Federal Environment Assessment Review Office (EARP) hearings on the APP (April 1980), ship routing was a small section of the ship design and operational procedure development studies. It was assumed that the routing would be along the "traditional" summer route to the Canadian arctic. This route followed the west coast of Greenland through Davis Strait and Baffin Bay to the Northwater area and then followed the lead along the south coast of Devon Island through Lancaster Sound and Barrow Strait.

During the Environmental Assessment Review Panel hearing, residents of the communities adjacent to the ship route expressed concerns about the impact of shipping activity in seasons other than the open-water season. The most recent winter shipping in the area were the Manhattan voyages about a decade earlier. The EARP panel recommended that the APP was environmentally acceptable provided certain conditions were met. The Integrated Route Analysis and the resulting documentation were intended to comply with one condition: "The selection of ship routing should involve the integration of physical factors and biological factors so as to minimize adverse impacts on wildlife."[1]

It should be mentioned that the Panel mandate was to review the APP in areas north of 60°N latitude. The APP undertook to apply the route analysis exercise from that latitude to the southern terminal location. In the southerly reaches of the ship routing, marine traffic comes under the supervision of the Ministry of Transport traffic schemes and some areas of transit were limited to established shipping laws.

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[1] **Report of the Environmental Assessment Review Panel on the Arctic Pilot Project, October, 1980.**

The primary objective of the route selection process was the definition of a route that wouuld comply with the EARP condition. In addition, the project participants attached the requirement that public and ship safety factors be integrated with physical and biological factors in the selection process. The second objective of the study was to develop a document that would permit updating as data were received for various disciplines. The final objective was to develop an operational manual based on the route analysis to assist the vessels' crews in maintaining the primary objective.

ROUTE SELECTION FACTORS

The route selection team decided early in the planning stages that a single route designation would not adequately meet the requirements of the project, therefore a series of alternates would be adopted. The routes would be such as to provide as much latitude as possible for navigation while remaining consistent with the factors under evaluation and integration. The routes could vary with geographic area and time of year. The intention was to avoid as much as possible, areas of known hazard or sensitivity, e.g. icebergs, pack-ice, marine mammal concentrations or resource harvesting activities.

The general criteria mentioned earlier consisted of sub-topics. Physical environment encompassed hydrology, sea-ice, icebergs, sea conditions, weather conditions and navigational hazards; biological environment encompassed reviews of sea-bird and marine mammal distribution, discussions of the effects of ship traffic on animal populations, discussion of underwater noise effects on marine mammals and discussions of the vulnerability of animals to traffic and underwater noise. Resource harvest included hunting and fishing patterns, and ship track crossing. Economics considered the number of trips annually, fuel consumed, cargo delivered, cargo lost due to boil-off, percent of year in open water or ice, and distance to southern terminals.

The area of potential transit was divided into eight geographic regions between the northern and southern terminals. Parry Channel was divided near Barrow Strait into West Parry Channel and East Parry Channel extending west to Melville Island and east to Baffin Bay, respectively. Baffin Bay, Davis Strait and Labrador Sea were considered as regions. The remaining three regions boundaries were influenced somewhat by traffic management systems in the Strait of Belle Isle, Gulf of St. Lawrence region.

Prior to the integration process, each group involved in the study gathered all the data relevant to their discipline. Each group designated areas of concern along the route, for example, the ship operations group mapped "areas of avoidance" such as shallow areas and "areas of caution", such as fishing areas. The biologists identified sensitive areas such as the Devon Island lead and those adjacent to seabird colonies.

PUBLIC AND SHIP SAFETY

The safety of the ship and of the public was influenced by conditions imposed by the physical environment. The reliability of the ship is also a factor but is outside the scope of a route selection exercise.

The ship operation group identified shoals as areas of avoidance - shoals being fixed do not add a temporal factor to the route selection process. Areas of high iceberg density were also classed as areas of avoidance, however, the contours of iceberg density vary by season, area and sea-ice condition. Areas of lower iceberg density were classed as areas of caution and the same variables applied. To define high and low densities, conservative numbers were adopted: high density was defined as 100 icebergs per two degree square which corresponds to 1/85 km^2 at 70°N latitude, lower density was 60-100 icebergs per two degree square which corresponds to 1/140 km^2 to 1/85 km^2 at 70°N latitude.

The presence of concentrations of multi-year ice constituted an area of caution. Growlers and bergy bits were hazards to navigation. The regions where these features occurred were mapped and avoided to the extent possible. Fishing areas, areas of poor visibility and areas of heavy seas were classed as areas of caution because of the possibility of those three factors occurring simultaneously.

BIOLOGICAL ENVIRONMENT

The biological aspects were discussed under three headings: effects of ship traffic, a biological synopsis and a geographic overview. Ship traffic through areas in which large numbers of birds and mammals spend all or part of the year would result in interactions. Interactions were defined as a circumstance in which the presence of a ship alters the behavior of the animals. The animals could be sensitive to the presence of a ship but the interaction is not necessarily harmful to the individual or species concerned. Individuals may move away from or out of the path of a ship for a short period and the interaction would have no long-term effect on the well-being of the animals. Individuals of other species may be harmfully affected by the presence of ship traffic, these animals were considered vulnerable to the effects of shipping. The vulnerability may be at the level of the individual or at the population level. The latter situations would require the application of mitigative measure.

The possible effects of ship traffic could arise from such things as passages close to bird colonies, interaction with the flightless murre migration and underwater noise interfering with marine mammal hearing and vocalization. An area of avoidance of ten kilometre radius was established around bird colonies to prevent disturbance. The interaction with flightless migration of murres was considered to be of low impact due to the low densities of birds. The underwater ship noise question was analysed on a species basis using all the information available. Estimates of ship-generated sound levels, length of time of exposure, season, and geographic area had to be considered in assessing the vulnerability of marine mammals to ship sound. Quantitative information was used as much as possible but there were geographic areas and species of marine mammals for which very little useful data existed. Such instances were identified and summarized the Integrated Route Analysis document.

The geographic overview provided a concise summary of distributions of birds and mammals for each geographic section. It was intended to provide the biological background for the process of integration and route selection.

RESOURCE HARVEST

All areas where resource harvesting occurred were noted, this included commercial fisheries in the Baffin Bay - Davis Strait area, marine mammal harvesting areas along Baffin Island, Greenland and along Parry Channel. Passage through areas with commercial fishing vessels at work was not unique to APP and hence was not a designated concern. Areas and times of fishing activities would be incorporated in operational manuals. Inshore areas of mammal harvest along Baffin Island and Greenland were to be avoided.

The area with the greatest potential for interaction of harvesting activities and shipping is Barrow Strait near the community of Resolute Bay. The Inuit of Resolute Bay were concerned the ship tracks would prevent travel across the sea ice and the ship traffic would cause a change in the naturally recurring ice crack pattern.

To address these concerns, a series of meetings were held with the Resolute Bay Hunters' and Trappers' Association at which cooperative studies were planned and initiated. A computer model was used to give insight into the modification of crack patterns. A resource harvest study was initiated to provide data on hunting patterns, travel routes, and seasonality of the hunt. A series of observational trips and studies were initiated to address the ship track crossing concern. Inuit representatives participated in trips to Lake Melville, Labrador; Thunder Bay, Ontario and Tuktoyaktuk, Northwest Territories. There were track crossing trials performed using the Canmar Kigoriak in winter and spring. The track was crossed by skidoo pulling a loaded komatik without difficulty and follow-up work recorded refreezing of the track over several days.

ECONOMICS

Prior to initiation of the route analysis study, the APP developed a transit simulation model to provide the economic base case. This model was used in subsequent evaluations of all alternate routes. The model had a seven year data base (1972-1978) of detailed ice and meteorological information. The year of October 1976 through September 1977 was chosen for the simulated transits as physical conditions were considered to be average.

Economic comparisons were conducted to demonstrate the effect of altering the route. The comparisons were made for alterations in each geographic area, the number of trips per year, fuel consumed, cargo delivered, and length of time in ice, and open water were compared and a transportation efficiency figure was calculated for each alternate route.

ROUTE SELECTION PROCESS

The route selection process followed the steps outlined and discussed below:

i) The route selection team assembled all data available to the end of 1980 and completed the information chapters of the "Integrated Route Analysis",

ii) The ship operations group mapped all areas of avoidance and areas of caution,

iii) The biological environment group mapped all sensitive areas,

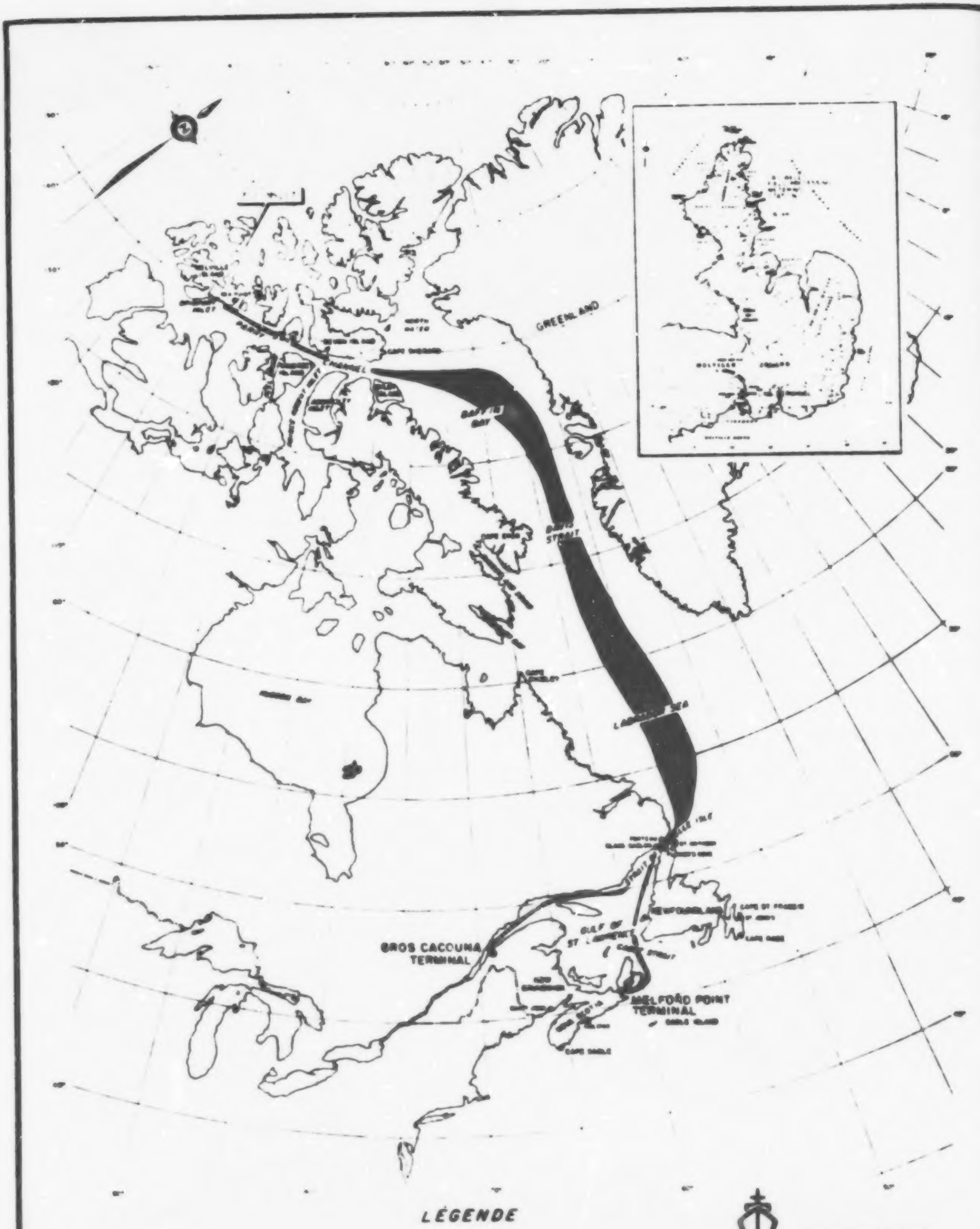
iv) A rigorous, formal methodology for route selection was concluded to be impractical due to some environmental data aspects. The biological information was not quantitative for all mammal species; population sizes, migration routes, seasonal distributions were not fully known and scientifically credibe data on the effects of underwater noise on marine mammals was only beginning to be assembled. Hunting patterns, travel routes and hunting areas near Resolute Bay were known to change and could only be portrayed in generalized terms,

v) The decision was made to use an iterative process whereby a series of discussions would be held of all aspects for route selection,

vi) But the environmental and physical science representatives on the team had a parallel concern based on different reasons that would become a major limiting factor. The environmental members wanted to avoid the continental shelf zones through Davis Strait and as far north as possible in Baffin Bay for the following reasons: (1) the migration routes of some marine mammals were on the shelf and there were resource harvest activities occurring there as well. (2) the iceberg contour delineating high density was above the continental shelf along both coasts, which precluded the traditional route to the north. The team set a zone of avoidance to extend 100 kilometres off the east coast of Baffin Island and the west coast of Greenland.

vii) It then was time to select routes. The team, after considering the data assembled, decided that the ships could transit anywhere between the exclusion boundaries in a safe, environmentally acceptable and economical manner. Hence, the corridor interpretation was accepted and the previously designated extremely narrow routes were discarded.

The final step in the process consisted of the preparation of a series of maps identifying the preferred route through the Northwest Passage. This route is now being used as a guideline by the Government/Industry "Environmental Advisory Committee on Arctic Marine Transportation", which is coordinated through Canada's Ministry of Transport.


GREENLAND
BAFFIN BAY
DAVIS STRAIT
LABRADOR SEA
NEWFOUNDLAND
GULF OF ST LAWRENCE
GROS CACOUNA TERMINAL
MELFORD POINT TERMINAL
LÉGENDE
CORRIDOR DU GAZODUC
Arctic Pilot Project
ELÉMENTS PRINCIPAUX

WORKSHOP SUMMARY

Appendix I

Workshops were held under the three main session themes: I - Methods for Siting and Routing, II - Elements of the Process and III - Regulation, public Interest and Decision-Making. Key factors or issues which should be taken into account in state-of-the-art route and site selection and which were raised in the various session papers provided the basis for workshop decisions. A summary of these discussions is given below.

Session I "Methods for Siting and Routing"

Workshop Summary

S.H. Janes

1. Introduction

The understanding of the process associated with the siting and routing of energy facilities has undegone an evaluation over the last several years. This has produced a much less structured picture of environmental assessment. With the evolution has come a far better appreciation of the process elements and the roles the participants all play.

Workshop Session at Banff '84 grappled with this problem. Out of these exercises emerged a conceptual framework that offers a better manner in which to display the process. This has been entitled, "A Conceptual Model of Energy Facility Siting and Routing".

The model portrays the assessment of an energy facility in the midst of a "setting" composed of socio-economic, environmental and political factors. All elements of the energy facility's history from the initial scoping through to closure are surrounded by open communication channels - channels that allow information to flow equally to all participants.

Each of the elements within the model represents conceptual statements of stages in the process of siting and routing energy facilities. The accompanying figure describes this model, while the text to follow outlines the elements.

2. The Model

2.1 Open Communication

By definition this implies an openness to disclosure by all participants - the proponents, regulating agencies, and the public too. In the comprehensive approach open communication occurs throughout all stages of the project and between the stages as well. But there must be some flexibility which all parties should accept as being necessary. Proponents must retain a certain measure of privilege in the disclosure of what information is appropriate at the particular stage in the assessment.

Communications with the public must be "aimed" at the public in an easily understood, totally "up-front" method. More often than not the best communicators are the proponent's technical teams, but they must drop the jargonize and:

- talk in a manner the public understands and,

- listen

2.2 Scoping

This is seen as an honest and accurate defining of the extent and nature of the proposal, the area of public interest, and the government's concern - as seen to exist at this early stage in the project.

By extension, scoping provides a focus for research that leads to definition of regulatory proceedings, data requirements, study methods, public interest, public involvement programs and so on. Depending on the nature of the project it could even conclude on whether or not the project is viable (no go) or if it requires major modification. While the necessity of some form of scoping is felt essential, its requirements should not be regulated. Rather it should be applied "where and as it fits."

2.3 Staging

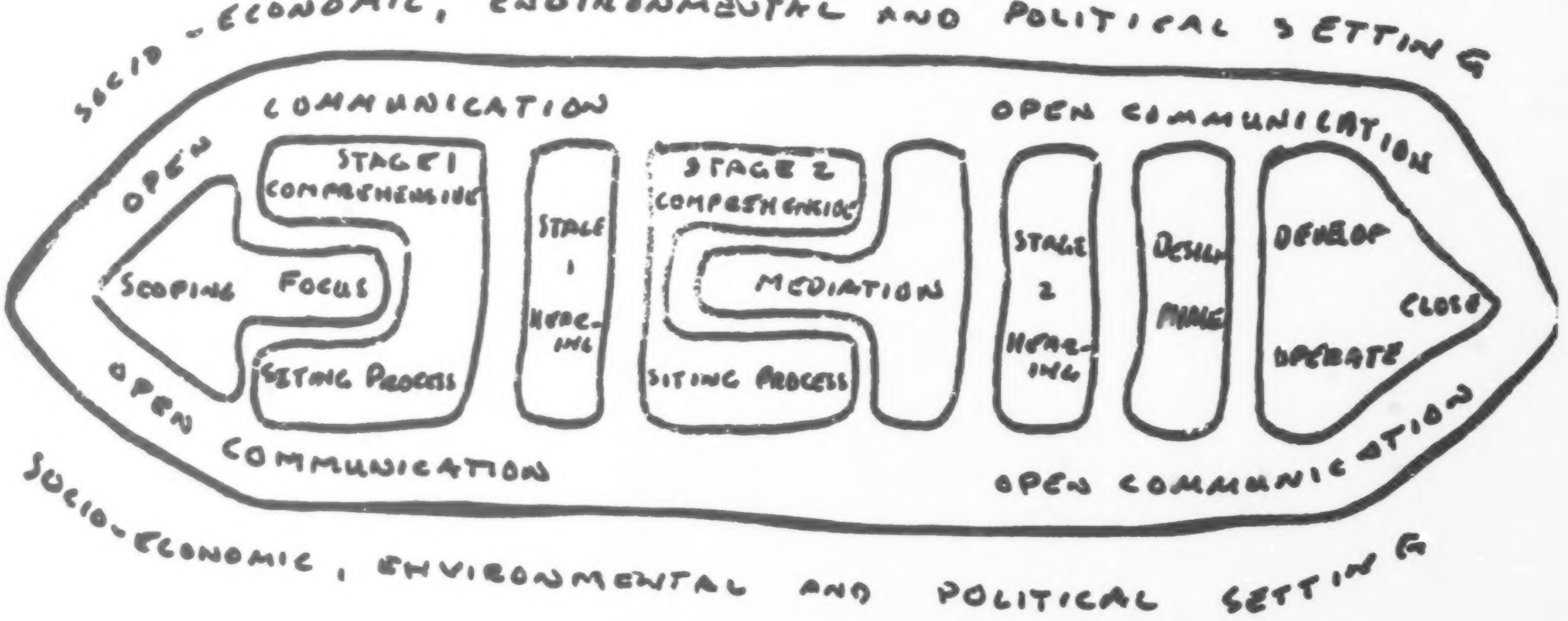
While not necessarily essential to all project assessments, there are benefits (both financial and procedural) in staging the analytical process so that broad areas with open-ended opportunities are narrowed down to a well defined credible proposal. This narrowing down process must be undertaken with public, government, and special interest group's impact.

Although a clear argument exists for staging of the assessment process, the same cannot necessarily be said for the hearings. To a substantial degree this depends upon the particular application. Very complex proposals may require staging to clear governmental commitments (financial or licensing). Further requirements may be necessary to subdivide the stages into components such as "technical need" hearings or "social/environmental impact" hearings.

2.4 Mediation

The primary objective of mediation is to deal with major problems outside of the hearing process through the evolution of mutually agreed upon solutions among the affected parties.

Mediation should not be regarded as the "answer to it all". To be effective it must be founded on a clear understanding of the potential impacts and therefore is unlikely to be a fair and useful technique too early in the assessment process.


SOCIO-ECONOMIC, ENVIRONMENTAL AND POLITICAL SETTING
OPEN COMMUNICATION
OPEN COMMUNICATION
SCOPING
FOCUS
STAGE 1 COMPREHENSIVE SITING PROCESS
STAGE 1 HEARING
STAGE 2 COMPREHENSIVE SITING PROCESS
MEDIATION
STAGE 2 HEARING
DESIGN PHASE
DEVELOP
CLOSE
OPERATE
OPEN COMMUNICATION
OPEN COMMUNICATION
SOCIO-ECONOMIC, ENVIRONMENTAL AND POLITICAL SETTING

A CONCEPTUAL MODEL OF ENERGY FACILITY SITING AND ROUTING

S H JANES

While it allows the public to be drawn into the assessment process this must be done cautiously and openly so that there is some integrity to the conclusions. When this is achieved the results of mediation can be used as direct evidence or even evidence-in-chief at hearings to reduce the extent of contested matters.

Mediation can involve not only trade-offs and compensation but can include the development of agreed upon mitigation measures.

The process of mediation, although of obvious benefit in an open and comprehensive routing approach, should remain voluntary.

3. Specific Proglem Issues identified by the Workshop

3.1 Public Input Problems

- study Terms of Reference are open-ended, have a tendency to confusion - lack public input,
- lack of defined methods for evaluating social values,
- lack of understanding of what constitutes communication and communicating,
- too often only opposition-oriented,
- hearings too late for public input,
- the not-in-my-background syndrome (NIMBY),

Solutions

- public should help during scoping in the drafting of Terms of Reference
- open disclosure of project and findings of each stage in a manner understandable to the public,
- careful consideration to public in qualifying the interests of special groups (farm communities, Mennonites, etc.)
- full documentation of all public input,
- well-run public hearings.

3.2 Overly Complex Process and the Need for Streamlining

- overall need to clarify roles and to streamline process of review,
- time to complete assessment process too long,
- overlapping jurisdictions and intergovernmental wrangling over responsibility - risk of multiple reviews,
- lack of consistency in evaluation criteria,
- lack of communication between government and proponents on new regulatory requirements.

Solutions

- establish of project review co-ordinating committees within government to streamline reviews,
- consolidate legislation by modifying existing Acts to incorporate development condition etc. as opposed to creating new Acts,

- establish regular exchanges between industry, government and the public on how the assessment process is working or should work,
- require interventions to be filed in advance and to require the intervenor limiting his arguments to the filing.

3.3 Accountability

- too much potential for political interference or for pressure group actions,
- lack of a basis for developing a system of evaluation, of "expert" credentials for the giving of evidence in hearings.

Solutions

- formalize and publicize the project setting,
- a more professional approach to environmental and socio-economic evidence (and data analyses) should be sought. Credential reviews, codes of ethics and perhaps an accreditation process should be promoted by governments and industry for those involved in the assessment process,
- retain the option of awarding costs where the interventions have not had any substance (or are frivolous).

4. An Overview of the Papers and the Direction for Future Studies

Review of the papers presented in Session I concludes:

- generally a more comprehensive approach is emerging with issue focussing assisting in the definition of the study programs. In some cases issue focussing dominates the initial stages with detailed study providing the reinforcement,
- openness of the entire assessment process is becoming the more experienced strategy in terms of public invovement,
- a far greater array of extremely usable techniques for public communication now exist - as common knowledge by proponent and review agencies alike,
- interesting and hightly useful techniques are emerging to assist in qualifying and compraing alternatives,
- integration of technical desciplines (engineering) with the "soft" sciences is becoming commonplace,
- public participation in project assessment and development is proving to be a worthwile experiment by the proponent.

As a final overview observation there clearly appears to be a maturing of the professional bodies involved in environmental assessment. Methodologies are no longer seen as being specific to certain types of projects but rather as one of many techniques to be utilized by the professional in carrying out the assessment and in communicating the findings.

METHODOLOGY IN NORTHERN ROUTING INVESTIGATIONS--
ONE CONSULTING TERRAIN ANALYST'S PERSPECTIVE

by

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ABSTRACT

Route selection and assessment methodologies have changed considerably over the last 25 years. The one discussed in this paper has evolved from the author's own work and experience in terrain analysis over this period. That work includes the selection and evaluation of more than 100,000 kilometres of prime and alternative routes for highways, railways, pipelines and power transmission lines, nearly all of them located in northern Canada. Methodologies necessarily vary from one project to the next, but those applied on major route studies are controlled to a large extent by established project objectives, land use considerations, terrain conditions, regulatory guidelines including environmental and social concerns, the level of investigation deemed necessary, and money available for carrying out the work. The estimated construction, operation and maintenance costs of routes traversing different types of terrain are also very important. As each situation dictates, a variety of data on preferred and competing lines are identified, mapped, analyzed, correlated and evaluated. The last 10 to 15 years has also witnessed an increasing trend toward greater interfacing of terrain analysts with specialists making environmental (e.g. archeological/vegetation/mammal/fish/bird), social and socioeconomic studies. Methodologies followed on northern pipeline routes incorporate the collection and analysis of relevant map and report data, the classification and mapping of terrain conditions from satellite imagery and airphotos and their integration with geotechnical and hydrological data, and with environmental, social and political constraints and concerns. A provisional list of steps followed on a typical northern route study is presented. Different terrain mapping legends are discussed along with some of the many biophysical factors affecting route selection. The role of airphoto and space imagery interpretation in corridor and right-of-way selection and in terrain typing and problem identification is emphasized, notably the recognition and evaluation of critical surficial processes and biophysical environments.

INTRODUCTION

The refinement of methodologies followed in northern route investigations has received increasing attention over the past 25 years. Those presented here relate mainly to my own experience selecting and evaluating highway, transmission line and pipeline routes, most of them located in northern Canada. Over 100,000 kilometres of routes have been looked at when all of the alternative routings are added in. They include provincial, interprovincial and a few international route studies, and were made in the period 1956 to 1984. Commonly, long segments of these routes traverse remote and sparsely habitated lands, where reliable data on local terrain and environmental conditions is scarce. Figure 1 shows the locations of pipeline routes that I have studied from different maps, scales and types of airphotos and satellite images in the period 1969 to 1984.

My special interest is the interpretation of surficial processes and features from conventional panchromatic airphotos, although many of the interpretations are supplemented by the acquisition and interpretation of relevant map and other sensor data, such as colour infrared and satellite imagery.

The selection of northern routes and sites 25 years ago was based almost entirely on the evaluation of terrain conditions and their relation to engineering and cost considerations. However, in the last 15 years increasing emphasis has been given to safety features and integrity of the route, and to envisaged environmental effects and socio-economic considerations, including possible political implications that a northern route or site development might have. By taking these additional concerns and constraints into consideration the traditional route location engineer frequently finds that he or she is one member of a team of specialists responsible for carrying out a succession of carefully phased study assignments. Generally during the first phase of these assignments a number of competing route corridors are examined, and the best one is chosen based on an evaluation of constraints, concerns, and estimated costs. Locations and widths of general route corridors depend in large measure on the nature of the indicated constraints. On long routes especially, the width of corridor studied will often vary from one segment to the next. The information in this paper deals mainly with the first phase, or stage, and with the analysis of terrain along routes crossing sparsely settled lands in northern Canada.

A second and more detailed routing stage involves closer and more costly investigations, and the production of a larger number of detailed maps and plans, surface and subsurface data profiles, and related books or volumes covering the level of information required by regulatory boards, commissions and agencies of government (see the National Energy Board Route Approval Procedures, Information Bulletin 1983).

METHODOLOGY

Establishing the Terrain Analyst's Guidelines

Before the terrain analyst starts gathering the many maps, reports and imagery that are available, that individual should have a very clear appreciation of the client's objectives. The client may be a government agency or utility, a private company or a consortium of companies, with or without participating governmental agencies. In any event proper liaison cannot be stressed too much. If this is done it can prevent (or at least reduce) many problems arising during later stages of the routing investigations. In addition, proper coordination should be set up before a significant amount of corridor selection work is done. Moreover, this liaison should be maintained throughout route selection and appraisal and regulatory body approval -- and, I believe, even through the implementation of detailed field surveys and route construction.

The terrain analyst should be familiar with the route selection and approval procedures of regulatory bodies, and with applicable federal and provincial environmental assessment and review processes. Usually this means obtaining the latest publications on land use and ecological land survey guidelines related to environmental and social impact analysis (see the publications titled: "National Energy Board Route Approval Procedures, Information Bulletin, 1983"; and "An Ecological Framework for Environmental Impact Assessment in Canada," by Gordon E. Beanlands and Peter N. Duinker, Institute for Resource and Environmental Studies, Dalhousie University, 1983; and "Ecological Land Survey Guidelines For Environmental Impact Analysis, " Ecological Land Classification Series No 13, Lands Directorate, Environment Canada and Federal Environment Assessment and Review Process). An awareness of such guidelines is necessary because the terrain analyst's major involvement concerns the identification, classification and mapping of terrain features, including surficial processes, environments, landforms, materials, and their significance. The recognition of surficial processes extends to the degree of susceptibility of a parcel of terrain to manmade disturbance resulting from the proposed construction.

The amount of data required by the client at a given stage in routing investigations varies with the money available for a study and the level of information required at that time. In the case of terrain data this usually entails the preliminary analysis of existing map and report data. It also entails the interpretation of Landsat images and mosaics made from them, small-scale airphoto mosaics, and stereoscopic high altitude (small-scale) panchromatic airphotos. The particular level of investigation that is undertaken can vary substantially, and each study is a little different. As indicated, the terrain analyst usually takes direction from those paying for the work. In some situations a preliminary office study of existing maps and reports covering a route corridor is all that is required. On the other hand, a succession of studies of several general route corridors may be needed to select a favored corridor and to identify short competing segments along it. These studies usually culminate in the identification of a preferred route. Specialists in the earth,life and social sciences often contribute importantly in this phase of the route selection and assessment.

Market economics and politics typically play major roles; and the terrain analyst of necessity is guided by them. I will not go into further detail here because of the number and complexity of issues and their significance at different stages of investigation.

Working with Other Specialists

On major projects the terrain analyst not only works closely with those responsible for establishing routing objectives (the proponent), but also with specialists whose individual personal knowledge and information impinges directly or indirectly on the route selection and assessment process. Based on my own experience I think immediately of geotechnical engineers doing borehole and geophysical work, including field and laboratory testing of materials; of hydrotechnical engineers carrying out river engineering investigations, including erosion, sedimentation and ice studies; and of pipeline engineers working on facility design and construction cost estimates. All these groups operate largely in an engineering capacity. At different times these groups will meet with specialists carrying out environmental/ecological and social/socioeconomic studies to discuss issues and concerns, particularly any constraints on routing. The timing of these meetings is important because the people working on site-specific facility location and design, for example, may have to re-do much of their work, often at appreciable expense, if for environmental or social reasons changes in routing are recommended late in a given stage of the investigations.

Steps Followed in Northern Routing and Siting -- One Example

The sequence of steps followed by the terrain analyst can vary substantially with the type of route (e.g. highway vs railway vs pipeline or powerline), specific objectives and requirements of the study, stage in the investigation, the type and quality of data that are available and also relevant, and regulatory guidelines among other factors. As a result, the following list of steps is generalized. Yet it is a list from which necessary changes can be easily made.

(1) Prepare a provisional list covering the kinds of information required. Make the list just as detailed as possible.

(2) Gather maps and reports that are relevant to the route selection and assessment process. Where available they should include bedrock and surficial geology maps, terrain and geomorphology maps, land use and land capability maps, topographic maps having different scales and contour intervals, ecological land survey maps, wildlife habitat maps and forestry maps, among several others. The list below is modified after one in the publication titled: Ecological Land Survey Guidelines for Environmental Impact Analysis, Ecological Land Classification Series No. 13, Lands Directorate, Environment Canada and Federal Environmental Assessment Review Office):

Topographic maps
Hydrographic charts
Canada Land Inventory critical area maps
Canada Land Inventory land use and land
  capability maps
Ecological (biophysical) land survey maps
Surficial and bedrock geology maps
Terrain and geomorphological maps

Agricultural soil survey maps
Provincial forest inventory maps
Northern Land Use Information Series maps
Arctic Ecology Map Series maps
River basin and watershed study maps
Migratory bird information maps
ALUR reports and maps
Flood risk maps and reports
Water resource data reports and maps
Climatic data reports and maps
Provincial and national atlasses

The terrain analyst usually finds that most of these maps and reports are available and relatively inexpensive to buy. Even so, many of them were prepared with objectives other than routing or siting investigations. Yet they often provide a helpful reference and basic information that can be quickly integrated with site specific information obtained by office airphoto interpretation and field reconnaissance by helicopter and, in places, by walking over the terrain.

(3) Prepare a provisional list of anticipated biophysical constraints and concerns. Also make this list just as detailed as possible. Enlist the help and guidance of other specialists.

(4) Obtain a list of all available types and scales of satellite imagery, thermal and radar imagery, airphoto mosaics and aerial photography, including conventional black and white panchromatic, normal colour, and black and white and colour infrared photography. Usually a complete listing of available imagery can be obtained within hours, if not a day or two.

(5) Join together, into a mosaic, maps of the same kind (*e.g.*, topography, bedrock geology, surficial geology, land use, ecological survey, etc.). False colour composite Landsat images generated from bands 4,5,7 at a scale of 1:1,000,000 may also be mosaicked. Assemble block or single strip mosaics of contact airphotos, using every other print of the smallest scale of good quality

contact airphotos available. Usually that scale will be somewhere between 1:80,000 and 1:50,000.

(6) Select general corridors, taking into consideration the guidelines and route constraints already mentioned (see, also, below). The most direct route, allowing for constraints (such as excessive relief, water bodies, settlements, etc.), is normally included among the initially competing route alternatives.

(7) Prepare reproducible transparencies of maps showing the general corridors, with critical environmental and social constraints and major terrain controls highlighted. These maps may be reproduced at scales of 1:1,000,000, 1:500,000, 1:250,000, 1:100,000, or 1:50,000 depending on first stage study objectives and the scales of available maps and airphoto and space imagery traversed by the corridor.

(8) Meet again with the client's senior representatives and other members of the route selection and evaluation team, such as geotechnical and hydrotechnical engineers, environmental and social impact specialists. These discussions usually deal with known and desired data relating to engineering, environmental, social, political and cost considerations. Gaps in information, based on what exists and what is required, are identified. Discuss and rate competing corridors. Decide whether further office or field work is required, and whether or not sufficient data are available in order to select a favored route corridor.

(9) Establish a suitable legend to be used in mapping the terrain. Several alternative legends are available from which to choose (see Figures 2, 3, 4, 5). Slightly different terrain mapping legends apply to different types of routes, and to different stages in the route selection and assessment process. I use the legend that in my judgement best fits established project requirements at the time.

(10) Type and map the terrain along the selected route corridor. This usually involves the identification and classification of landforms and surface earth materials, topography, drainage and vegetation. So far as possible, identifiable permafrost and peatland features are also mapped during terrain typing for northern route surveys.

(11) Examine the high altitude stereoscopic airphotos that have been assembled into strip mosaics and terrain typed and, depending on the knowledge and experience of the airphoto interpreter and his or her familiarity with landscape features in the area, within the terrain typed corridor select the route that appears best from an overall engineering, environmental, social, and cost standpoint.

(12) Review again, in a meeting of all those concerned with route selection and impact assessment and costs, the selected route, terrain and other parameters. At this stage, finer details of the terrain and of the route location can be discussed at length.

(13) Organize field reconnaissance trips to inspect the route corridor, the route selected within the corridor, and features of interest or concern along it. Usually the reconnaissance is done by helicopter. Route reconnaissance at this stage may involve two or more helicopters, transporting individuals having different training, experience and objectives. De-briefing sessions may follow these reconnaissance trips. At them, relevant maps, colour composite satellite images, and small-scale airphoto strip mosaics (which can be examined in 3-D) are reviewed and regional and local constraints are discussed. These sessions can be very lively and interesting, with a wide range of contributions coming from those participating in the discussion.

(14) Return to the office, discuss the route in further detail and finalize the route. The selected R/W may then be re-photographed at some suitable scale, such as 1:25,000. The final route is usually plotted on a strip mosaic at 1:25,000 scale, or thereabouts. The terrain is then classified and mapped again, but in greater detail, and follow-up field surveys are outlined. Detailed field surveys are governed to a large extent by airphoto interpretation work done during detailed terrain mapping. All facility sites should be selected and evaluated from the study of stereoscopic airphotos. Geotechnical investigations may include geophysical surveys, borehole drilling at selected points of significance (compressor sites, airstrips, etc.) along the route, and at airphoto-identified borrow sources. Hydrotechnical surveys often include preparing annotated profiles at proposed (and nearby alternative) stream crossings and an evaluation of erosion, sedimentation and river ice considerations. Obviously there should be close coordination between the terrain interpreter and the geotechnical and hydrotechnical personnel carrying out field surveys. This also applies to pipeline engineers doing facility layout and design work, along with the preparation of related cost estimates. The results of detailed work by people making regional and local environmental and social studies are also carefully coordinated.

(15) A good deal of thought and effort goes into how to best display all of the accumulated information on maps and in volumes of written text. Preparation of final project documentation is usually a major undertaking. A computerized databank information system is usually developed, taking into account how the data can be retrieved and how it will be used.

Some Factors Affecting Route Selection and Assessment

Before photo interpreters can classify and map terrain, ranging from very general in some instances to great detail in others, they must be able to confidently recognize natural features in the landscape. They should also have a clear appreciation of their origin and significance in routing or siting. The terrain analyst should have a good understanding of geological processes that form and modify large and small features in the landscape, as well as their appearance in different types and scales of airphotos. Only then can the interpreter convincingly defend why a particular parcel of land has been avoided and why another has been favored.

Other things being equal the shorter the route the better because on major northern routes the per-kilometre construction cost may run to several hundreds of thousands or even millions of dollars. Accordingly, the terrain analyst must have clearly defined and defensible reasons for increasing the length of very costly facility routes. The importance of a given factor may also change from north to south along a route. Actively deepening or enlarging thaw basins in permafrost terrain may be very important along one segment of the route, for example, and may not apply to other sections of the alignment. The same reasoning applies to environmental and social concerns. Any provisional listing by the terrain specialist should be added to or modified by other specialists working on the project. A complete list would be long indeed. The list below is one that I prepared originally over ten years ago and have updated periodically since. It applies mainly to pipeline routes in the permafrost and peatland regions of northern Canada. Some factors are closely interrelated. In any event they are things that the photo interpreter/terrain analyst should be able to identify, classify, map and describe in legends and in reports with a good deal of confidence. Most of the 35-mm glass slides used in my talk relate to examples of these factors, which were identified during the course of pipeline routing and siting studies in northern Canada and Alaska.

(1) Topography, mainly the amount of relief, changes in relief and relation to construction ease and route stability.

(2) Drainage, including rills, sheetwash, creeks, active layer seepage, springs, etc.

(3) The origin, composition and variability of surficial soil materials.

(4) Bedrock outcrops, bedrock-controlled relief, type and hardness of bedrock related to excavation and slope stability.

(5) Peatland type, estimated thickness range of peat, whether the peat is frozen or unfrozen, and probable distribution of ground ice if any.

(6) Permafrost features, probable ground ice types, permafrost variability, identification of ice-rich vs ice-poor terrains.

(7) Anticipated thaw settlement and frost heave problems (qualitative) related to the different types of terrain identified and the climatic factor.

(8) Slope instability identification, classification and risk hazard assessment, especially along escarpments, steep hillsides and valley sides.

(9) Erosion feature type (wind, water, ice, thermal) and hazard potential.

(10) Stream crossings, inferred type of material in river banks and bed, indications of channel stability.

(11) Ditch excavatability using different ditching methods (hard vs soft rock, surface boulder concentrations, frost-shattered bedrock, frozen sand, bouldery till, etc.).

(12) Earthwork excavation volume and type (R/W blasting and backhoe vs a ditching machine).

(13) Vegetation type, extent of cover, commercial significance of timber, wildlife habitat, R/W clearing.

(14) Route length (shortness, as noted above, is preferred because of possible major cost savings).

(15) Preferred siting of appurtenant facilities such as compressor stations, off-loading points or staging sites, airstrips, construction campsites, water supplies, waste disposal sites, dock sites, harbour sites, wellsites, gathering lines.

(16) Granular/borrow materials location and evaluation.

(17) Features or phenomena such as pingos, palsas, solution features (collapse), icings (aufeis), strudel scour, ice jams, effects of river ice scraping along the stream bed and banks, old vs active thaw features in both mineral and organic soil materials, among others.

(18) Archeological constraints.

(19) Environmental/ecological concerns and constraints related to terrain stability and to land cover and land use.

(20) Social or socioeconomic concerns or constraints.

The significance of these and other factors can vary significantly with local terrain conditions. Indeed their significance often varies from one section of route alignment to the next. Usually at the outset, knowing something about the geography of the corridor traversed I will prepare a tentative list of the terrain types that are likely to be encountered, and rate them as to their expected degree of sensitivity to disturbance from activities associated with facility routing and siting.

SOME EXAMPLES FROM REMOTE SENSING STUDIES IN NORTHERN ROUTING INVESTIGATIONS

A presentation on methodology, with long lists, can become confusing and overly generalized if specific examples from past studies are not included. In selecting 20 or so 35-mm glass slide examples I have looked for one key demonstration point in each slide.

Sensor Type and Scale: From the General to Site Specific

Here I would like to demonstrate the concept of looking first at the "big picture" before looking at the detailed picture -- i.e. going from regional controls to site specific controls. To illustrate this I have chosen two areas: the locality around Creswell Bay on Somerset Peninsula, and Richards Island in the Mackenzie Delta. I will interpret terrain and environmental factors first from satellite imagery, then from high altitude panchromatic airphotos, from low altitude aerial photographs, and then on-site ground reconnaissance.

Outlining Critical Areas from Engineering and Environmental Standpoints

I have selected two areas where satellite imagery and airphotos are both helpful. One shows a subarctic region where I have carried out more than a dozen route and site investigations since 1956. It covers the Wekusko Lake to Lake Winnipeg region in Manitoba. The other area is located in the Queen Maud Gulf Bird Sanctuary between Bathurst and Chantrey Inlets, and shows differing geological settings and bird habitats on Landsat imagery and in ground views.

Detecting Changes in Landscapes Using Multitemporal Remote Sensing Techniques

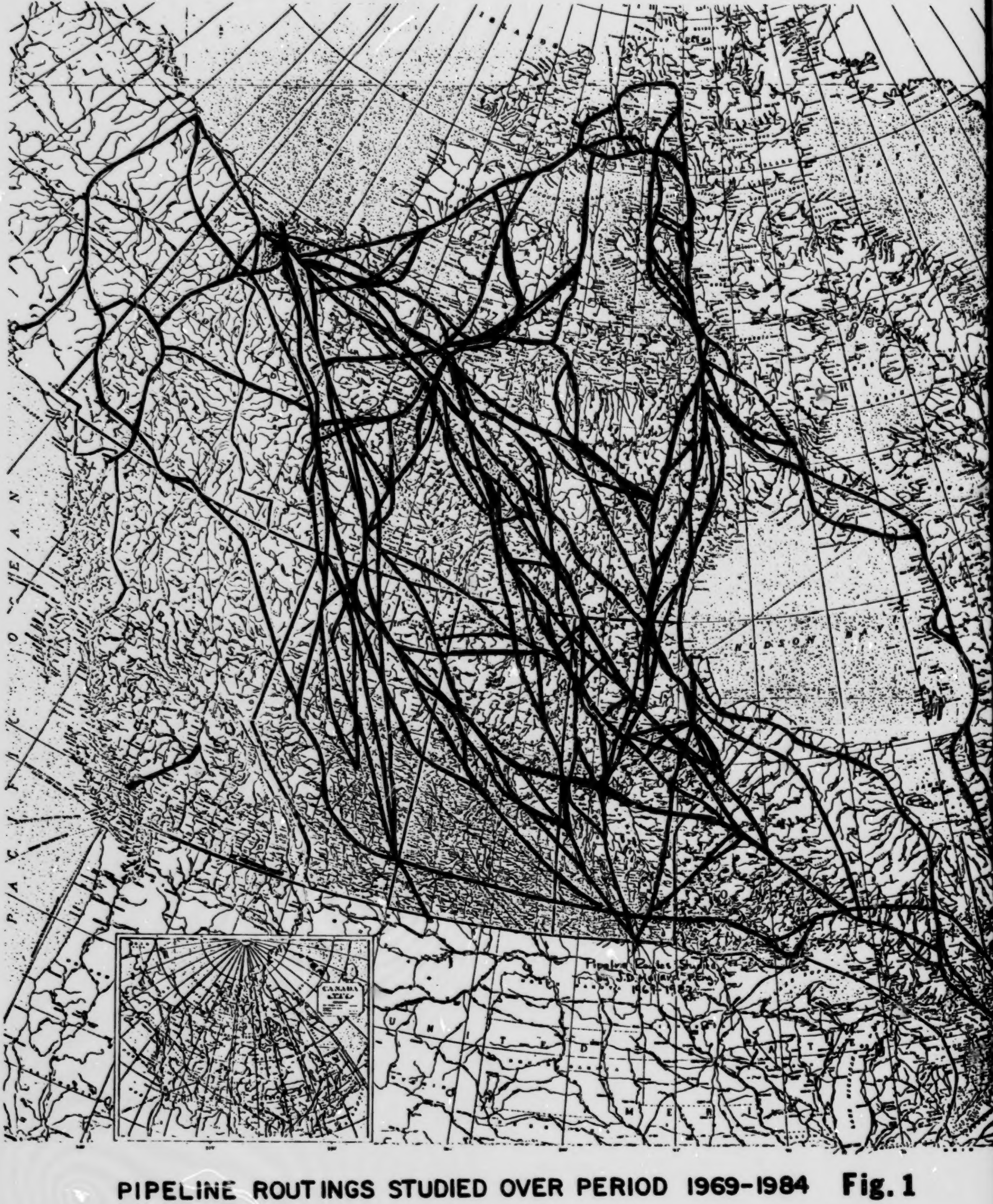
There are best times of the year to view a scene from both spacecraft and aircraft imagery. To illustrate this I have selected two examples. One project involves a power transmission line route study in a region of extensive peatland, located north of Tobin Reservoir in Saskatchewan. The second project is the Slave River delta in the Northwest Territories. This latter study illustrates the technique of effectively combining enhanced multispatial, multispectral and multitemporal imagery. The airphotos studied cover the period 1925 to 1980 and deal with geomorphic and hydrologic changes.

Detailed Mapping of Terrain Types and Subtypes

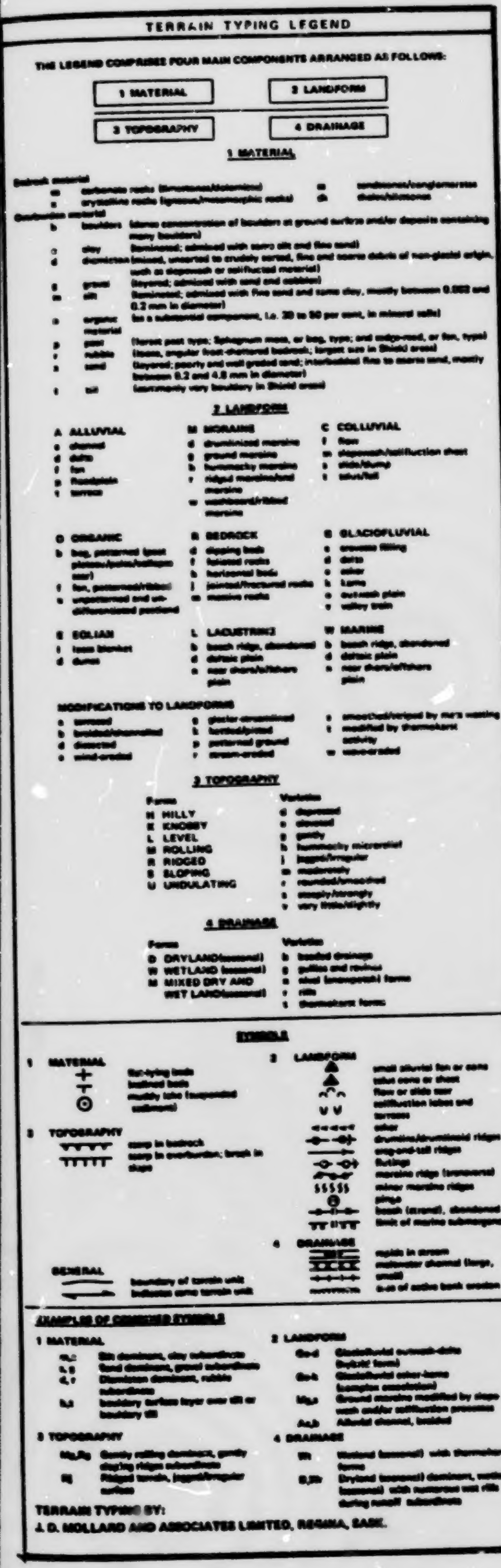
In route selection and assessment the terrain analyst often classifies the terrain first into broad types, and then into subtypes. One example of this is peatland terrain -- also referred to as muskeg and organic terrain. As seen in the imagery shown, the peatland types can be divided into types and subtypes depending on whether they are bogs or fens, frozen or unfrozen, thick or thin peat.

Recognizing the Significance of Natural Processes in Detailed Facility Siting

Here I have chosen two examples: (1) unusual features along subarctic and arctic rivers, and (2) the Great Bear River to Norman Wells area in the Mackenzie River valley.


PACIFIC OCEAN
HUDSON BAY
UNITED STATES
CANADA
Pipeline Routes Studied
by J.D. Mollard P.Eng
1969-1984

PIPELINE ROUTINGS STUDIED OVER PERIOD 1969-1984 **Fig. 1**



TERRAIN TYPING LEGEND

THE LEGEND COMPRISES FOUR MAIN COMPONENTS ARRANGED AS FOLLOWS:

1 MATERIAL	2 LANDFORM
3 TOPOGRAPHY	4 DRAINAGE

1 MATERIAL

Bedrock material
- m carbonate rocks (limestones/dolomites) — ss sandstones/conglomerates
- x crystalline rocks (igneous/metamorphic rocks) — sh shales/siltstones

Unconsolidated material
- b boulders (dense concentration of boulders at ground surface and/or deposits containing many boulders)
- c clay (laminated; admixed with some silt and fine sand)
- d diamicton (mixed, unsorted to crudely sorted, fine and coarse debris of non-glacial origin, such as slopewash or solifluction material)
- g gravel (layered; admixed with sand and cobbles)
- m silt (laminated; admixed with fine sand and some clay, mostly between 0.002 and 0.2 mm in diameter)
- o organic material (as a substantial component, i.e. 20 to 50 per cent, in mineral soils)
- p peat (forest peat type; Sphagnum moss, or bog, type; and sedge-reed, or fen, type)
- r rubble (loose, angular frost-shattered bedrock; largest size in Shield areas)
- s sand (layered; poorly and well graded sand; interbedded fine to coarse sand, mostly between 0.2 and 4.8 mm in diameter)
- t till (commonly very bouldery in Shield areas)

2 LANDFORM

A ALLUVIAL
- c channel
- d delta
- f fan
- p floodplain
- t terrace

M MORAINE
- d drumlinized moraine
- g ground moraine
- h hummocky moraine
- r ridged moraine/end moraine
- w washboard/ribbed moraine

C COLLUVIAL
- f flow
- m slopewash/solifluction sheet
- s slide/slump
- t talus/fall

O ORGANIC
- b bog, patterned (peat plateau/palsa/collapse scar)
- f fen, patterned/ribbed
- u unpatterned and undifferentiated peatland

R BEDROCK
- d dipping beds
- f foliated rocks
- h horizontal beds
- j jointed/fractured rocks
- m massive rocks

G GLACIOFLUVIAL
- c crevasse filling
- d delta
- e esker
- k kame
- o outwash plain
- v valley train

E EOLIAN
- l loess blanket
- d dunes

L LACUSTRINE
- b beach ridge, abandoned
- d deltaic plain
- n near shore/offshore plain

W MARINE
- b beach ridge, abandoned
- d deltaic plain
- n near shore/offshore plain

MODIFICATIONS TO LANDFORMS
- a [illegible]
- b braided/anastomosed
- d dissected
- e wind-eroded
- g glacier-streamlined
- k kettled/pitted
- p patterned ground
- r stream-eroded
- s smoothed/striped by mass wasting
- t modified by thermokarst activity
- w wave-eroded

3 TOPOGRAPHY

Forms	Varieties
H HILLY	d depressed
K KNOBBY	e elevated
L LEVEL	g gently
M ROLLING	h hummocky microrelief
R RIDGED	j jagged/irregular
S SLOPING	m moderately
U UNDULATING	r rounded/smoothed
	s steeply/strongly
	v very little/slightly

4 DRAINAGE

Forms	Varieties
D DRYLAND(seasonal)	b braided drainage
W WETLAND (seasonal)	g gullies and ravines
M MIXED DRY AND WET LAND(seasonal)	n [illegible] forms
	r rills
	t thermokarst forms

SYMBOLS

1 MATERIAL
- flat-lying beds
- inclined beds
- muddy lake (suspended sediment)

3 TOPOGRAPHY
- scarp in bedrock
- scarp in overburden; break in slope

GENERAL
- boundary of terrain unit
- indicates same terrain unit

2 LANDFORM
- small alluvial fan or cone
- talus cone or sheet
- flow or slide scar
- solifluction lobes and terraces
- esker
- drumlins/drumlinoid ridges
- crag-and-tail ridges
- flutings
- moraine ridge (transverse)
- minor moraine ridges
- pingo
- beach (strand), abandoned
- limit of marine submergence

4 DRAINAGE
- rapids in stream
- meltwater channel (large, small)
- [illegible] of active bank erosion

EXAMPLES OF COMBINED SYMBOLS

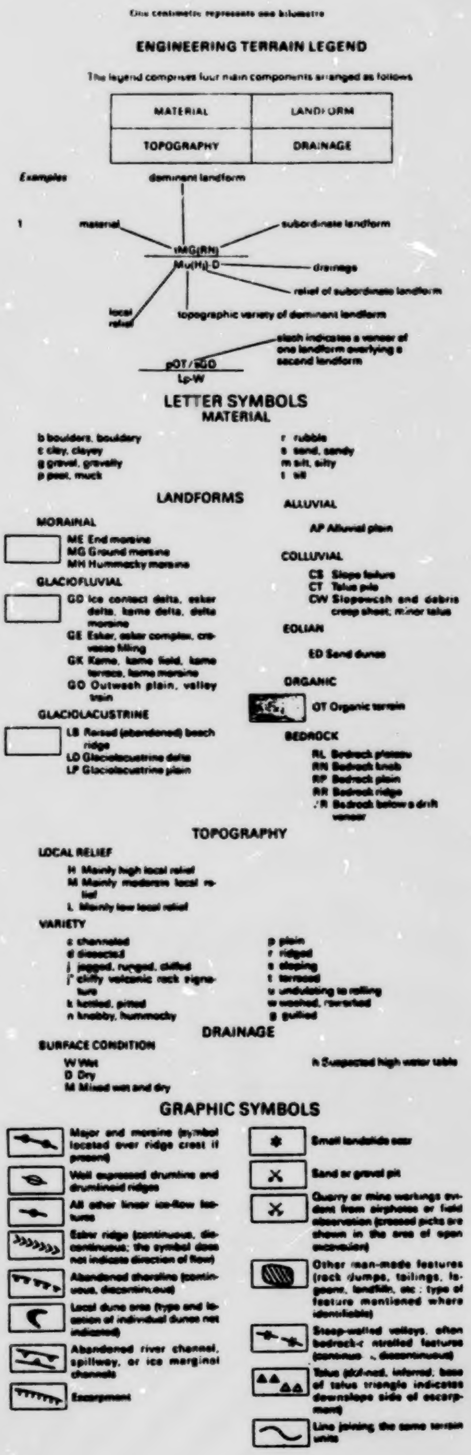
1 MATERIAL
- m,c Silt dominant, clay subordinate
- s,g Sand dominant, gravel subordinate
- d,r Diamicton dominant, rubble subordinate
- b,t bouldery surface layer over till or bouldery till

2 LANDFORM
- Go-d Glaciofluvial outwash-delta (hybrid form)
- Ge-k Glaciofluvial esker-kame (complex association)
- Mg,s Ground moraine modified by slope wash and/or solifluction processes
- Ac,b Alluvial channel, braided

3 TOPOGRAPHY
- Mg,Rs Gently rolling dominant, gently sloping ridges subordinate
- Rj Ridged terrain, jagged/irregular surface

4 DRAINAGE
- Wt Wetland (seasonal) with thermokarst forms
- D,Wr Dryland (seasonal) dominant, wetland (seasonal) with numerous wet rills during runoff subordinate

TERRAIN TYPING BY:
J. D. MOLLARD AND ASSOCIATES LIMITED, REGINA, SASK.



One centimetre represents one kilometre

ENGINEERING TERRAIN LEGEND

The legend comprises four main components arranged as follows

MATERIAL	LANDFORM
TOPOGRAPHY	DRAINAGE

Examples

1

sMG(RN)
Mu(Hj)-D

dominant landform
material
subordinate landform
drainage
relief of subordinate landform
local relief
topographic variety of dominant landform

pOT/sGD
Lp-W

slash indicates a veneer of one landform overlying a second landform

LETTER SYMBOLS
MATERIAL

- b boulders, bouldery
- c clay, clayey
- g gravel, gravelly
- p peat, muck
- r rubble
- s sand, sandy
- m silt, silty
- t till

LANDFORMS

MORAINAL
- ME End moraine
- MG Ground moraine
- MH Hummocky moraine

GLACIOFLUVIAL
- GD Ice contact delta, esker delta, kame delta, delta moraine
- GE Esker, esker complex, crevasse filling
- GK Kame, kame field, kame terrace, kame moraine
- GO Outwash plain, valley train

GLACIOLACUSTRINE
- LB Raised (abandoned) beach ridge
- LD Glaciolacustrine delta
- LP Glaciolacustrine plain

ALLUVIAL
- AP Alluvial plain

COLLUVIAL
- CS Slope failure
- CT Talus pile
- CW Slopewash and debris creep sheet; minor talus

EOLIAN
- ED Sand dunes

ORGANIC
- OT Organic terrain

BEDROCK
- RL Bedrock plateau
- RN Bedrock knob
- RP Bedrock plain
- RR Bedrock ridge
- /R Bedrock below a drift veneer

TOPOGRAPHY

LOCAL RELIEF
- H Mainly high local relief
- M Mainly moderate local relief
- L Mainly low local relief

VARIETY
- c channeled
- d dissected
- j jagged, rugged, cliffed
- j* cliffy volcanic rock signature
- k kettled, pitted
- n knobby, hummocky
- p plain
- r ridged
- s sloping
- t terraced
- u undulating to rolling
- w washed, reworked
- g gullied

DRAINAGE

SURFACE CONDITION
- W Wet
- D Dry
- M Mixed wet and dry
- h Suspected high water table

GRAPHIC SYMBOLS

- Major end moraine (symbol located over ridge crest if present)
- Well expressed drumlins and drumlinoid ridges
- All other linear ice-flow features
- Esker ridge (continuous, discontinuous; the symbol does not indicate direction of flow)
- Abandoned shoreline (continuous, discontinuous)
- Local dune area (type and location of individual dunes not indicated)
- Abandoned river channel, spillway, or ice marginal channels
- Escarpment
- Small landslide scar
- Sand or gravel pit
- Quarry or mine workings evident from airphotos or field observation (crossed picks are shown in the area of open excavation)
- Other man-made features (rock dumps, tailings, lagoons, landfills, etc.; type of feature mentioned where identifiable)
- Steep-walled valleys, often bedrock-controlled features (continuous, discontinuous)
- Talus (defined, inferred; base of talus triangle indicates downslope side of escarpment)
- Line joining the same terrain units

Fig. 2

The legend comprises four main components arranged as follows:

1. Material | 2. Landform

3. Topography | 4. Drainage

1. Material

BEDROCK MATERIAL

ca	carbonate rocks (limestones/dolomites)
x	crystalline rocks (igneous/metamorphic rocks)
ss	sandstones/conglomerates
sh	shales/siltstones

OVERBURDEN MATERIAL

b	boulders	(dense concentration of boulders at ground surface and/or deposits containing many boulders)
c	clay	(laminated, admixed with some silt and fine sand)
d	diamicton	(mixed, unsorted to crudely sorted, fine and coarse debris of non-glacial origin, such as slopewash or solifluced material)
g	gravel	(layered; admixed with sand and cobbles)
m	silt	(laminated; admixed with fine sand and some clay, mostly between 0.002 and 0.2 mm in diameter)
o	organic material	(as a substantial component, i.e. 20 to 50 per cent, in mineral soils)
p	peat	(forest peat type; Sphagnum moss, or bog, type; and sedge-reed, or fen, type)
r	rubble	(loose, angular frost-shattered bedrock; largest size in Shield areas)
s	sand	(layered; poorly and well graded sand; interbedded fine to coarse sand, mostly between 0.2 and 4.8 mm in diameter)
t	till	(commonly very bouldery in Shield areas)

---

2. Landform

A ALLUVIAL

- c channel
- d delta
- f fan
- p floodplain
- t terrace

M MORAINE

- d drumlinized moraine
- g ground moraine
- h hummocky moraine
- r ridged moraine/end moraine
- w washboard/ribbed moraine

C COLLUVIAL

- f flow
- m slopewash/solifluction sheet
- s slide/slump
- t talus/fall

O ORGANIC

- b bog, patterned (peat plateau/palsa / collapse scar)
- f fen, patterned/ribbed
- u unpatterned and undifferentiated peatland

R BEDROCK

- d dipping beds
- f foliated rocks
- h horizontal beds
- j jointed/fractured rocks
- m massive rocks

G GLACIOFLUVIAL

- c crevasse filling
- d delta
- e esker
- k kame
- o outwash plain
- v valley train

E EOLIAN

- l loess blanket
- d dunes

L LACUSTRINE

- b beach ridge, abandoned
- d deltaic plain
- n near shore/offshore plain

W MARINE

- b beach ridge, abandoned
- d deltaic plain
- n near shore/offshore plain

MODIFICATIONS TO LANDFORMS

- a terraced
- b braided/channelled
- d dissected
- e wind-eroded
- g glacier-streamlined
- k kettled/pitted
- p patterned ground
- r stream-eroded
- s smoothed/striped by mass wasting
- t modified by thermokarst activity
- w wave-eroded

---

3. Topography

FORMS		VARIETIES	
H	HILLY	d	depressed
K	KNOBBY	e	elevated
L	LEVEL	g	gently
M	ROLLING	h	hummocky microrelief
R	RIDGED	j	jagged/irregular
S	SLOPING	m	moderately
U	UNDULATING	r	rounded/smoothed
		s	steeply/strongly
		v	very little/slightly

4. Drainage

FORMS		VARIETIES	
D	DRYLAND (seasonal)	b	beaded drainage
W	WETLAND (seasonal)	g	gullies and ravines
M	MIXED DRY AND WET LAND (seasonal)	n	nival (snowpatch)forms
		r	rills
		t	thermokarst forms

Fig.3· Terrain typing legend

Source: After J.D. Mollard

Symbols in mapped terrain units are arranged as follows:

Material	
Topography	Drainage

Material

OVERBURDEN MATERIAL

B	Excessive concentration of surface boulders and frost-shattered boulders; includes frost-heaved and frost-shattered bedrock.
T	Till. Generally bouldery with scattered surface boulders in Canadian Shield and limestone areas. Dominantly silty sand matrix in areas of Rx and Rss rocks, silty matrix in Rca rock areas, and a clay-rich matrix in Rsh bedrock areas.
G	Granular deposits. Undifferentiated, stratified sand and gravel; includes silt and boulders locally.
F	Fines. Mainly stratified, waterlaid clay, silt, and fine sand in varying proportions.
P	Peat. Includes fen and Sphagnum peat.

BEDROCK MATERIAL

R	Bedrock

DOMINANT ROCK TYPES (MODIFIER)

ca	limestone and dolomite
sh	shale and siltstone
ss	sandstone and conglomerate
x	Precambrian crystalline rocks (gneisses, granites, greenstones and allied hard rocks)

Topography

RELIEF APPEARANCE

H	Hilly
K	Knobby
L	Level
M	Rolling
R	Ridged
S	Sloping
U	Undulating

MODIFIER

c	choppy microrelief
d	depressed
e	elevated
g	gently
j	jagged or irregular
k	kettled
m	moderately
p	patterned ground
r	smoothly rounded
s	steeply or strongly

Drainage

SURFACE DRAINAGE CONDITION

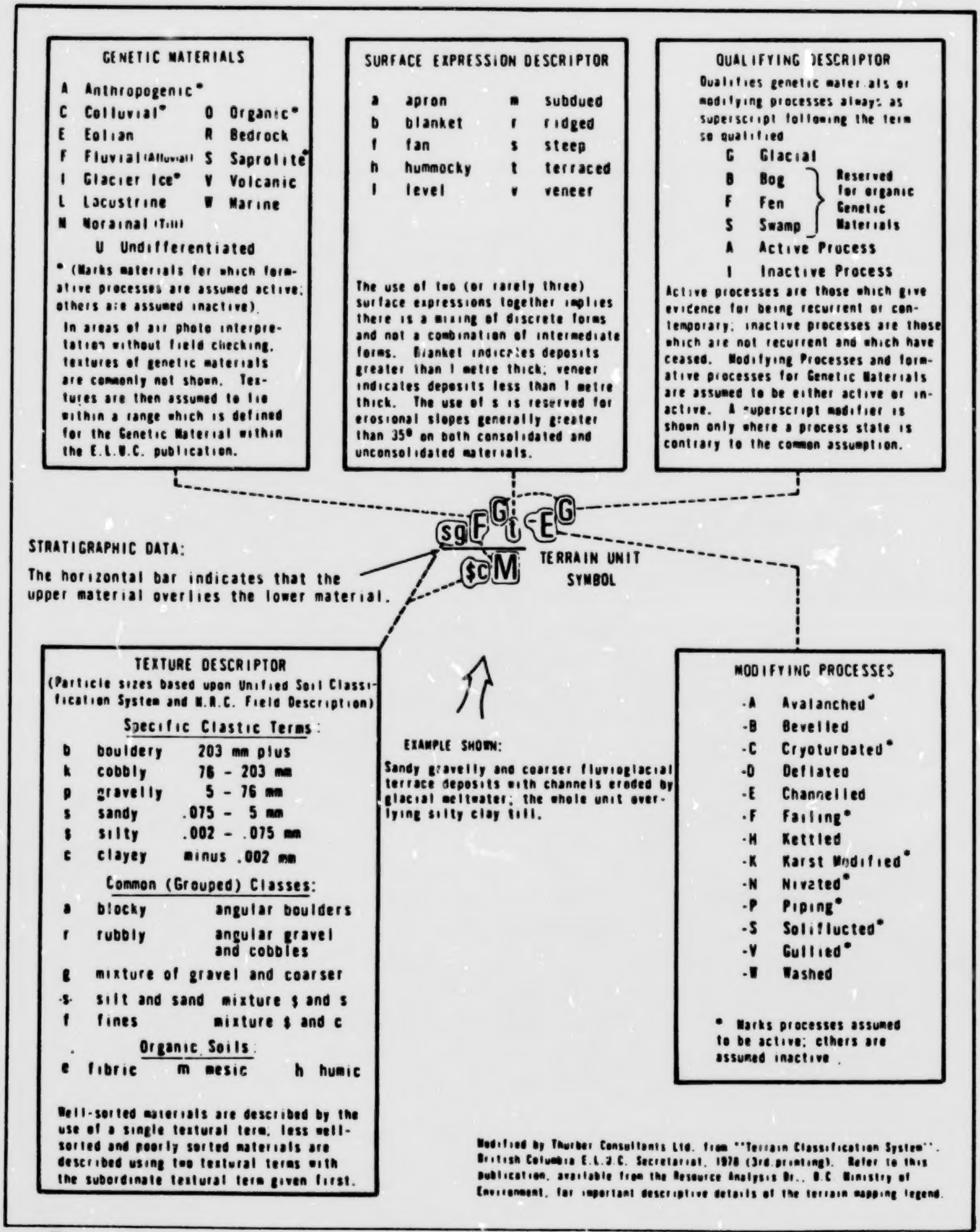
D	Topographically higher and better drained sloping areas, commonly with a wet active layer in permafrost areas; mostly smooth ridges and upper slopes in till areas.
W	Topographically lower areas; includes poorly drained flats and depressions in till areas, most low relief F areas, and all P areas.

MODIFIER

g	gullies
r	rills
t	thermokarst basins

Fig. 4 - Terrain legend

Source: After J.D. Mollard



GENETIC MATERIALS

A	Anthropogenic*		
C	Colluvial*	O	Organic*
E	Eolian	R	Bedrock
F	Fluvial (Alluvial)	S	Saprolite*
I	Glacier Ice*	V	Volcanic
L	Lacustrine	W	Marine
M	Morainal (Till)		

U Undifferentiated

* (Marks materials for which formative processes are assumed active; others are assumed inactive).

In areas of air photo interpretation without field checking, textures of genetic materials are commonly not shown. Textures are then assumed to lie within a range which is defined for the Genetic Material within the E.L.U.C. publication.

SURFACE EXPRESSION DESCRIPTOR

a	apron	m	subdued
b	blanket	r	ridged
f	fan	s	steep
h	hummocky	t	terraced
l	level	v	veneer

The use of two (or rarely three) surface expressions together implies there is a mixing of discrete forms and not a combination of intermediate forms. Blanket indicates deposits greater than 1 metre thick; veneer indicates deposits less than 1 metre thick. The use of s is reserved for erosional slopes generally greater than 35° on both consolidated and unconsolidated materials.

QUALIFYING DESCRIPTOR

Qualifies genetic materials or modifying processes always as superscript following the term so qualified

G	Glacial	
B	Bog	Reserved for organic Genetic Materials
F	Fen	
S	Swamp	
A	Active Process	
I	Inactive Process	

Active processes are those which give evidence for being recurrent or contemporary; inactive processes are those which are not recurrent and which have ceased. Modifying Processes and formative processes for Genetic Materials are assumed to be either active or inactive. A superscript modifier is shown only where a process state is contrary to the common assumption.

STRATIGRAPHIC DATA:

The horizontal bar indicates that the upper material overlies the lower material.

TEXTURE DESCRIPTOR

(Particle sizes based upon Unified Soil Classification System and N.R.C. Field Description)

Specific Clastic Terms:

b	bouldery	203 mm plus
k	cobbly	76 - 203 mm
p	gravelly	5 - 76 mm
s	sandy	.075 - 5 mm
$	silty	.002 - .075 mm
c	clayey	minus .002 mm

Common (Grouped) Classes:

a	blocky	angular boulders
r	rubbly	angular gravel and cobbles
g	mixture of gravel and coarser	
-s-	silt and sand	mixture $ and s
f	fines	mixture $ and c

Organic Soils:

e fibric m mesic h humic

Well-sorted materials are described by the use of a single textural term, less well-sorted and poorly sorted materials are described using two textural terms with the subordinate textural term given first.

EXAMPLE SHOWN:

Sandy gravelly and coarser fluvioglacial terrace deposits with channels eroded by glacial meltwater; the whole unit overlying silty clay till.

MODIFYING PROCESSES

-A	Avalanched*
-B	Bevelled
-C	Cryoturbated*
-D	Deflated
-E	Channelled
-F	Failing*
-H	Kettled
-K	Karst Modified*
-N	Nivated*
-P	Piping*
-S	Soliflucted*
-V	Gullied*
-W	Washed

* Marks processes assumed to be active; others are assumed inactive.

Modified by Thurber Consultants Ltd. from "Terrain Classification System". British Columbia E.L.U.C. Secretariat, 1978 (3rd printing). Refer to this publication, available from the Resource Analysis Br., B.C. Ministry of Environment, for important descriptive details of the terrain mapping legend.

Fig.5 - ELUC legend

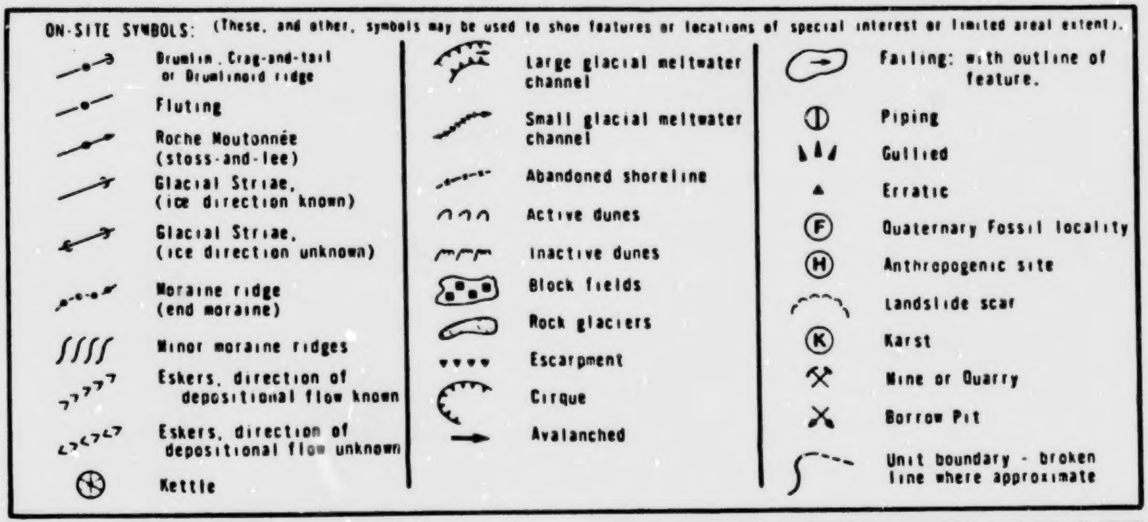

ON-SITE SYMBOLS: (These, and other, symbols may be used to show features or locations of special interest or limited areal extent).
Drumlin, Crag-and-tail or Drumlinoid ridge
Fluting
Roche Moutonnée (stoss-and-lee)
Glacial Striae, (ice direction known)
Glacial Striae, (ice direction unknown)
Moraine ridge (end moraine)
Minor moraine ridges
Eskers, direction of depositional flow known
Eskers, direction of depositional flow unknown
Kettle
Large glacial meltwater channel
Small glacial meltwater channel
Abandoned shoreline
Active dunes
Inactive dunes
Block fields
Rock glaciers
Escarpment
Cirque
Avalanched
Failing: with outline of feature.
Piping
Gullied
Erratic
Quaternary Fossil locality
Anthropogenic site
Landslide scar
Karst
Mine or Quarry
Borrow Pit
Unit boundary - broken line where approximate

Fig. 5 - ELUC legend (Cont'd)

COMPOSITE UNITS:

=	components on either side of this symbol are approximately equal in area.	example 1: Mb=R. Moraine blanket area roughly equals the exposed bedrock area.
/	the component in front of the symbol is more abundant (55 to 70%) than the one that follows.	example 2: Mb/R. Moraine blanket area is more than the area of exposed bedrock
//	the component in front of the symbol is considerably more abundant (70 to 90%) than the component that follows.	example 3: Mb//R. Moraine blanket area is considerably more than the area of exposed bedrock.

OIL AND GAS WELL SITING AND DRILLING IN MICHIGAN TO MINIMIZE ENVIRONMENTAL IMPACTS

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ABSTRACT

The site selection process for oil and gas wells is necessarily restricted when compared to the options available in siting other energy facilities. Oil and gas reservoirs have a fixed location, and drilling technology limits the offset distances. Environmental impacts at the drill site can still be minimized even though options are reduced. The process used in Michigan to minimize site impacts involves three elements:

1. Generic concept assessment - the generic assessment of the technolopgy and related impacts on the regional environment, with the goal of generating broad limits, standards and constraints.

2. Siting assessment and controls - making use of exclusion and constraint criteria and mitigation techniques in the evaluation of specific sites.

3. Construction and Production Controls - technical control with strict regulation and inspection, coupled with enforcement actions to insure that the generic concepts and site mitigation constraints are implemented.

The intent of this process is to identify common issues for statewide standards, while treating unique issues and sites on a case-by-case basis in order to insure fair and equitable regulation of the findustry in concert with wise resource management.

INTRODUCTION

The siting of major energy facilities involves a number of variables, including facility and site characteristics as well as engineering and environmental constraints. When a pipeline or powerline route is determined, wide variations to the route are often possible. Sour gas processing facilities and power plants have a relatively broad range of siting options available.

The range of options is severely restricted, however, in the siting of oil and gas wells'. Here the target reservoirs are fixed in location and the lateral distance that a drill rig may be located from these reservoirs is limited by the depth of the target formation and drilling technology. Siting to minimize environmental impacts can be accomplished when siting options are restricted, but it is necessary to combine to be effective. This broad concept is used in Michigan with some success.

THE OIL INDUSTRY IN MICHIGAN

The oil industry in Michigan is the largest mineral resources industry in terms of dollar value of raw material product, and there is an active and continuing program by the industry of hydrocarbon exploration, drilling and production. Michigan ranks ninth in the U.S. in oil production, with 32.2 million barrels of oil produced in 1983. There are nearly 500 active oil and gas companies in Michigan and, 795 wildcat and development wells were drilled in 1983. There are more than 6,000 oil and gas wells producing from 1.110 oil and natural gas fields.

The effects of oil industry on Michigan have been significant. Economically and socially, the industry by, its size and operations, provides jobs, fees to the state and to private investors and landowners. Environmentally, the industry has made a lasting mark on Michigan's countryside. The more obvious surface disruptions from well sites, pipelines and processing facilities are one type of impact. The less-obvious impacts of groundwater contamination and habitat disruption may be also significant, however, if not properly controlled.

The oil and gas industry is regulated by a 1929 state statute which was years ahead of its time. The statute establishes a Supervisor of Wells to regulate the industry, with the advice and counsel of an Oil and Gas Advisory Board made up of industry representatives. The Supervisor is charged to:

1. Foster the growth of the industry; and

2. Prevent waste.

Waste is of two varieties - waste of oil and gas from overproduction and unwise development, and pollution of the surface and subsurface environments.

The oil industry is very competitive, and this statute, by granting strong powers to the Supervisor, establishes a "judge" to rule fairly and equitably between the various factions of the industry.

Legislatures traditionally have had two approaches to ensuring that agencies respond to the intent of legislative policies:

1. Means - oriented agency forcing. Here the agency is told precisely which regulatory means should be used to reach the legislature's objective.

2. End-Oriented Agency Forcing: The agency is required to define its own means to reach the ends, or goals, set forth by the legislature. In some instances, the policy alone is set, and the agency is required to set both goals and means to carry out the policy.

The National Environmental Policy Act of 1969 is an example of "end-oriented agency forcing" (Caldwell 1982). Environmental impact statements required under NEPA do not prescribe technical means or standard administrators to show that they had kept those goals in mind in their planning and decision making. NEPA thus provides the flexibility to permit changes and alternations with experience and learning the Michigan Oil and Gas Act is another example of "ends-oriented agency forcing", only it has resulted in forcing both the agency and industry to work towards prevent waste, both economic and environmental. The statute sets end goals but leaves the implementation to the agency as a result, Michigan has strong policy and enforcement programs to prevent damage to the environment that occurs in the production of oil and gas.

MINIMIZING IMPACTS

Oil and gas can be produced with an acceptable risk of environmental degradation if proper planning and controls are applied at the right places and in the proper manner. When proper planning and/or controls are absent, the risk identification of problems and when the concern for consensus overwhelms good problem resolution.

The establishment of standards for facilities where hydrogen sulfide exists is an example. Concern over the toxic and corrosive nature of hydrogen sulfide, and the knowledge that many Michigan wells contain significant concentrations prompted establishment of a state government task force to establish informal guidelines in 1975 to provide safeguards in the drilling and production of sour wells. Contingency plans are required before drilling, siting restriction or exclusions were defined and drilling practice controls were established. At production, fences, gates and warning signs vapor emissions controls are required to protect the public and company personnel. The contingency plans and drilling safeguards were accepted with industry consensus, but there has been resistance by individual operators to production safeguards requiring a number of enforcement actions. guidelines in 1975 to provide safeguards in the drilling and production of sour wells. Contingency plans are required before drilling, siting restriction or exclusions were defined and drilling practice controls were established. At production, fences, gates and warning signs vapor emissions controls are required to protect the public and company personnel. The contingency plans and drilling safeguards were accepted with industry consensus, but there has been resistance by individual operators to production safeguards requiring a number of enforcement actions.

To correct weaknesses in the guidelines that experience has identified since drawn up in 1975, we are now moving through consensus to revise these baseline standards to address siting, equipment and practice.

Even though the sour gas problem was anticipated, the process did not forsee all eventualities. In 1982 a rig worker was overcome while mix drilling mud which used sour brine inadvertently brought on site. No rules covered the use of sour brine. The Supervisor issued an Emergency Order stopping the process, held a hearing, and issued an Order soon thereafter which controlled this aspect of the H2S problem.

Another successful example of consensus involves fresh water wells at oil well drill sites used as a source fresh water wells at drilling.

As the result of concerns from the Michigan Department of Public Health about improperly drilled fresh weater wells at drilling sites, staff studied the problem with a committee from the industry. A mutually agreeable resolution to the problem was worked out among Department of Public Health, Geological Survey Division and industry, which was formalized as an order which applied to all wells drilled in the state. It set siting standards, construction standards and transfer of ownership requirements.

Consensus does not always work easily nor rapidly however. The thick formations of salt which are encountered in drilling many Michigan wells result in considerable amounts of salt and salt fluids handled at most drilling sites, and large amounts of salt left on site. Estimates vary with location and well, but as much as 88 tons of salt may be handled at the typical well, with as much as 36 tons left on site after the brines are pumped off. Nearly nine out of ten wells are drilled at sites with sand and gravel, or other permeable soils at the surface. There is often no protection between the surface and the groundwater table, so any salt that is lost goes directly into the groundwater. Complaints of water wells down-gradient of oil wells becoming contaminated with salt began to be received.

A task force of department staff and industry was established to look at the problem. Their report made a number of recommendations including the use of pit liners and methods to reduce the net amount of salt left at the site.

In 1981, Orders were issued which prohibited spidering, or draining off of brines from the reserve pit. At the same time, a 20 mil PVC liner was required under all pits in the state as a precaution against groundwater contamination.

Three years have now passed since the Supervisor's Order was issued on an interim basis. Staff is concerned that the interim solution has improved but not solved this problem and a new staff/industry and environmental group task force is now meeting to review staff recommendations to prohibit on-site disposal of drilling cuttings. A consensus may be difficult to reach and a contested hearing will be required, with environmental groups and staff aligned against industry with Supervisor of Wells being judge. These cases illustrate the flexibility of the process of concept assessment to solve common government-industry-environmental problems. Resolving a problem once is more efficient than having to solve it evedry time that it comes up. The process does not depend on consensus, but it works much more quickly if there is a common understanding and effort is made by all parties to make the process work. If necessary the adversary climate of contested hearings is available. Early involvement of all affected parties is important. The outcome must be workable and enforceable; sometimes this is the most difficult requirements of all.

Siting Assessment and Controls

The second element of the process of minimizing impacts is effective siting assessment and controls. The permit to drill an oil well carries with it the standards from the generic assessment stage. An EIA is required to be prepared by the operator for each proposed drill site in addition. This EIA is informal document which relates the known impacts of drilling to the specific site environment. It is not a voluminous document, but sufficient to allow staff to make a field inspection and initial evaluation. We use a multiple-disciplinary approach, involving field staff from several disciplines to review (1) constraint and exclusion criteria; (2) technical aspects of the application; (3) the site impact potentials for several resource indices, and (4) potential for off-site impacts. Staff reviews, for example, flora and fauna at the site, streams, wetlands, proximity to residences, air quality impact potentials, soil erosion, etc. Constraint and exclusion criteria are used for certain resources, such as wetlands and streams, sensitive land uses, H2S setbacks and minimum well spacing.

The review of drilling permit applications is done at the field level with staff oversight. Considerable autonomy within bounds is given to the District Supervisor to allow early identification of problems and resolution. Sites are approved, moved or denied on the basis primarily of field reviews. Mitigation is required at field request, and may include berms or dikes, noise controls, odor controls, restriction on mud pits and/or brine handling etc. The requirements of the site may dictate a wide range of requirements to prevent waste. To improve the abilities of field staff, regular training sessions in technical and environmental areas, such air emissions, wetland designation, etc. are provided.

Siting an oil well in the Sand Lakes Quiet area in northern lower Michigan is an example of site review to minimize impacts. The Sand Lakes is a state designated non-motorized recreation area in Grand Traverse and Kalkaska counties. It is popular with hikers, backpackers and cross-country skiers. Prior to designation as a quiet area in 1973, several oil and gas development leases were issued, and one of the lessee oil companies filed for a drilling permit within the Quiet Area boundary.

The company proposed a directional well from a surface location just inside the Quiet Area boundary to a bottom hole target roughly in the center of the Quiet Area. The surface location was at the limit of the lateral offset from the target; it was also the only acceptable surface location because of slopes and a lake nearby.

The staff reviewed the proposed location and alternate sites and conceived that any other alternate site outside the Quiet Area would result in more local impacts than the proposed site. An active effort was made by staff to involve the community and local environmental groups and a compromise was reached allowing the proposed surface location. At the same time, strict drilling and production controls were imposed by the state and measures were taken to revise the states management of the entire Quiet Area.

Construction and Production Controls

Regulation in this area is primarily enforcement oriented. The industry has input into the concept assessment stage, and as an individual permittee in the Siting Assessment stage. At the critical thrid stage, however, the base line standards and the permit mitigation measures are all spelled out as conditions of the permit, or as rules or orders of the Supervisor. These are only on paper, however, unless there is follow-through. Regulation is the way to insure follow through. There is never enough staff to regulate all aspects of the permits, especially since production may continue for years and continual surveillance is necessary. Further, government can never hope to be on top of the technology of the oil business. The need for strong enforcement by trained field staff is great. A gooed field staff, working with good planning and controls can take adantage of this type of end-oriented regulation and the competitive nature of the industry. There is a burden on the regulator, however, to be fair, even handed and practical in regulation.

SUMMARY

Although options for siting may be restricted, as in the case of target - specific oil and gas wells, environmental impacts may still be minimized through the three stage process of:

1. Generic or concept assessment, where consensus and early problem identification work better than confrontation or reactionary management;

2. Siting assessment and controls, using a multidisciplinary approach and creativity in mitigation; and

3. Construction and production controls, or close follow thru to requirement and standards.

This process is not unique to oil and gas development nor is it restricted to state government rgulation. The concepts, and the process, are applicable at many levels and situations. That is, spearate issues which are common and which are suited to common treatment, treat on a case-by-case basis those issues which are unique, and follow-through with proper controls and supervision to see that they are carried out.

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SESSION II A - DATA MANAGEMENT ISSUES

ENVIRONMENTAL DATA ISSUES IN GENERIC ASSESSMENT OF THE CANADIAN NUCLEAR FUEL WASTE MANAGEMENT PROGRAM*

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ABSTRACT

Unlike most other papers presented at this Symposium, this paper will not deal with siting or routing directly. Rather, the intent is to illustrate the importance of generic assessment, and treatment of associated data limitations, in introducing a new technology or concept before site selection even begins, e.g. in this case, the concept for nuclear fuel waste disposal in Canada. In particular, the paper will focus on the broad data base approach for the pre-closure part of this generic assessment, and how this approach will help deal with uncertainties and variabilities as well as set the stage for future siting studies.

1.0 INTRODUCTION

In 1978, the Canadian and Ontario governments signed an agreement establishing the Canadian Nuclear Fuel Waste Management (NFWM) Program. The NFWM Program is seeking to develop a disposal concept which is technically effective and feasible as well as environmentally and socially acceptable. The concept proposed by Atomic Energy of Canada Ltd (AECL) is to immobilize used fuel, or fuel recycle waste, and subsequently emplace it deep underground in a stable, igneous rock formation within the Canadian Shield. Figure 1 is an artist's illustration of the fuel disposal concept. Concept Assessment is the first and current phase of the NFWM Program. It involves research, development and generic assessments of the disposal concept and related fuel waste management activities. It is assumed that a disposal centre would eventually be located within the Ontario portion of the Shield, since this province will be the primary source of used fuel in Canada for the foreseeable future. The plan anticipates three interim assessments prior to a formal concept assessment submission in 1988. The initial assessment was issued in 1981 (AECL Technical Record TR-127). The second assessment is due to be issued in 1984 and the third assessment

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* Paper presented at the international meeting on "Facility Siting and Routing '84 - Energy and Environment", April 15-18, 1984, Banff, Alberta.

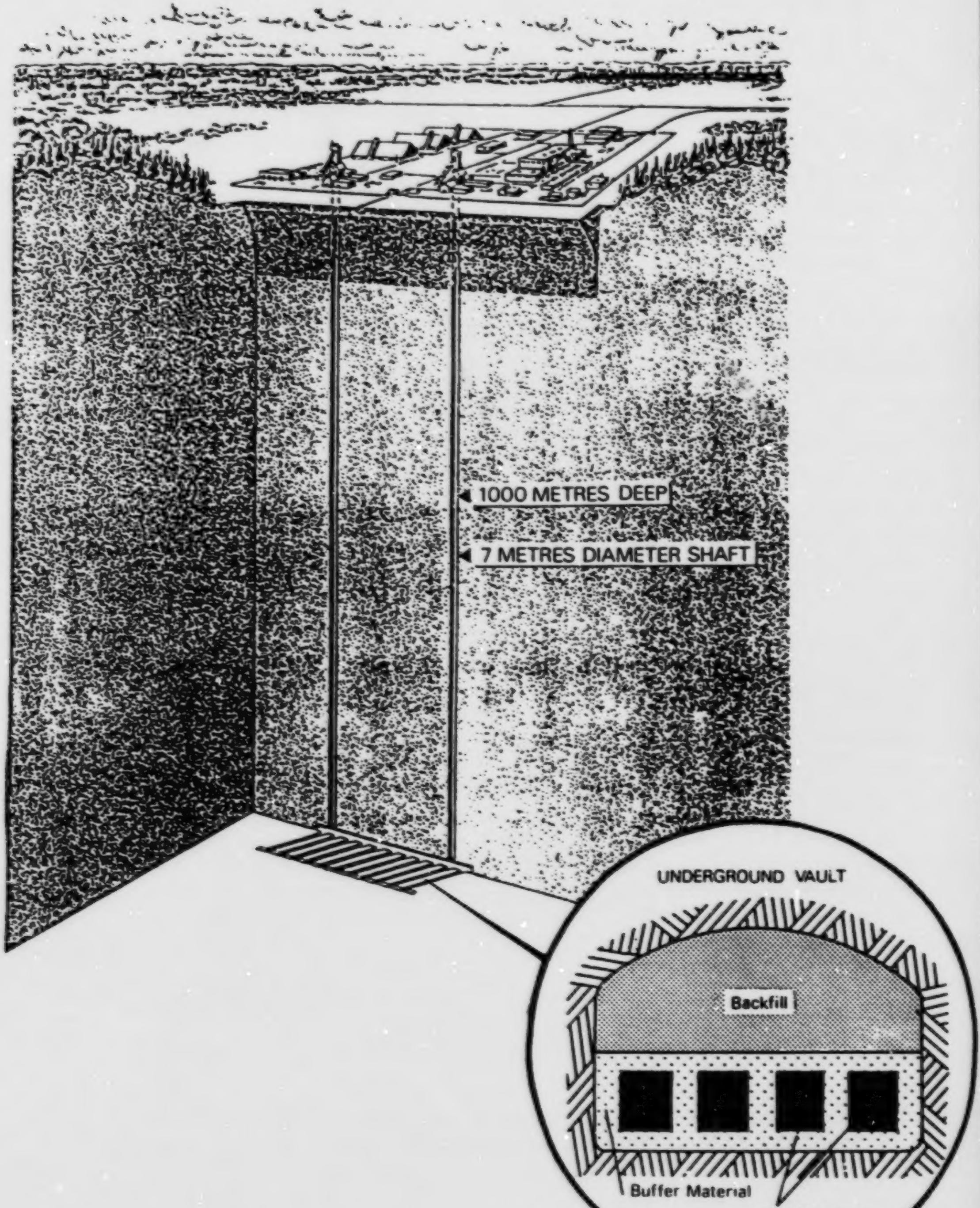

1000 METRES DEEP
7 METRES DIAMETER SHAFT
UNDERGROUND VAULT
Backfill
Buffer Material
Fuel Containers

FIGURE 1
Artist's Illustration of the Fuel Disposal Concept

in 1986. Interim concept assessment documents are reviewed by the public, the scientific community and an Interagency Review Committee representing the Atomic Energy Control Board, the Federal Department of Environment and the Ontario Ministry of the Environment. A formal concept assessment document will be published and submitted around 1988 for regulatory and government review including public hearings. Ontario Hydro is assisting AECL in many areas of this program, including the "pre-closure" part of the concept environmental and safety assessment(1,2). The division between pre-closure and post-closure periods is taken to be the point at which the underground vault and shafts have been backfilled and sealed, surface facilities have been removed and the site restored or released for some other use. AECL is doing the post-closure assessment. Although the emphasis of this paper is on Ontario Hydro's approach to pre-closure assessment, it also focuses on the linkage with AECL's post-closure assessment.

2.0 PURPOSE OF GENERIC ASSESSMENT

One of the basic principles embodied in the 1978 Canada/Ontario agreement is that site selection will not begin until the disposal concept has been thoroughly assessed and accepted by the appropriate authorities. Accordingly, since specific sites and environmental conditions cannot be assumed at this time, a generic assessment approach is necessary. This approach is considered appropriate for introduction of a major new technology or concept, such as nuclear fuel waste disposal, and is consistent with practice in other countries, e.g. United States, Sweden. However, this approach presents its own set of problems, including data limitations and uncertainties, as described in Sections 4 and 5.

3.0 REGULATORY POLICY AND GUIDELINES

3.1 Concept Assessment Review Process

A joint Canada/Ontario announcement in August 1981 set up a process for regulatory review, public hearings and government decision on the acceptability of the concept (Table 1). The Atomic Energy Control Board (AECB) will be the lead agency in this concept assessment process and will carry out its role through the powers assigned to it under the Atomic Energy Control Act. It will be assisted in the development of requirements and other regulatory functions by the Ontario Ministry of Environment and the Federal Department of Environment. Together these agencies form the Interagency Review Committee (IRC). Interested provincial governments will be kept informed and consulted as this process proceeds. As indicated in Table 1, government acceptance of the concept is required before any site can be selected for a demonstration facility.

TABLE 1

CANADA/ONTARIO CONCEPT APPROVAL PROCESS

1. Public Announcement: Announcement by the Governments of Canada and Ontario of the overall process to be implemented in the concept assessment phase of the waste management program.

2. Issuance of Initial Statement on the Regulatory Review and Assessment of the Disposal Concept: Issuance by the AECB of a statement on the regulatory review and assessment of the disposal concept for public review and comment. This statement will include requirements on the content of the AECL submissions and performance requirements on the impact of a sealed repository on the biosphere over long time periods.

   Concurrent issuance by the three IRC agencies of an explanation of the joint consultative nature of the regulatory review.

3. Submission of Interim Concept Assessment Document: Submission by AECL to the members of the IRC, interested groups, public libraries and Government offices across Canada of the Interim Concept Assessment Document, which will include a safety and environmental assessment, for review and comment.

4. Issuance of Final Statement on the Regulatory Review and Assessment of the Disposal Concept: Issuance by the AECB of the final statement on the regulatory review and assessment of the disposal concept. This document will provide a basis for decisions on the acceptability of the proposed concept.

5. Issuance of Updated Concept Assessment Documents: Updated Concept Assessment Documents issued by AECL from time to time including new data from the research.

6. Formal Submission for Acceptance of the Concept Assessment Document: A Formal Submission of the Concept Assessment Document for the acceptance of the AECB will be made by AECL. This is not expected to occur until several years after the start of the process. This document will also be submitted to the members of IRC, interested groups, public libraries and Government offices across Canada.

7. Review of Concept Assessment Document: Announcement by AECB of the receipt of the submission and of the specific arrangements and schedule for regulatory review including public consultation through a public hearing process under the auspices of the Federal Government. A report from the IRC on the concept assessment document will be made available to the public before the hearing.

8. Report from Public Hearing: Recommendations arising from the Public Hearing Process submitted to AECB by the responsible body and made available to the public.

9. Statement on Acceptability or Non-Acceptability of the Waste Disposal Concept: Issuance of a statement by the AECB on the acceptability, conditional acceptability, or non-acceptablity of the concept.

10. Concept Acceptance: In the case of acceptability, the Governments of Canada and Ontario may accept the concept assessment document. Acceptance would be a prerequisite to selection of any site for a waste disposal facility.

3.2 AECB Policy Statement and Regulatory Guide

In 1982, AECB issued a draft policy statement C-71 regarding the Concept Assessment phase(3). Since not all of the variables considered during Concept Assessment will be relevant to the site which is ultimately selected, the AECB acknowledges that it is neither necessary nor possible to examine every one of them in great detail at this stage. The data limitations associated with a generic assessment are considered acceptable if there is a reasonable expectation that the necessary data will become available later in the licensing process. Uncertainties in the data or Concept Assessment analyses must be clearly indicated and, where possible, quantified in appropriate ways. As will be seen further on, this requirement is similar to a 1976 Federal guideline for initial environmental evaluation (site selection) of nuclear power projects. The AECB accepts that regulatory judgement of the disposal concept must rely on predictive modelling results based on data from experiments, limited field investigation and existing data assembled from various previous studies.

In January 1984, AECB issued a proposed regulatory guide C-72 on siting considerations for Concept Assessment(4). The guide presents five general geological criteria by which the acceptability of potential sites (and therefore the concept) will be judged. This is only one of a series of criteria guides planned by AECB. The C-72 guide does not provide siting procedures or add to the policy discussion in C-71. However, there is no doubt that the fundamental geological considerations in C-72 will have a major bearing on how the transition is made from concept assessment to siting.

3.3 Federal and Ontario Environmental Guidelines

No guidelines specific to the NFWM Program have been issued by the Federal Department of Environment (DOE) or the Ontario Ministry of Environment (MOE). It is noteworthy, however, that the Federal guideline(5) issued in 1976 for Initial Environmental Evaluation (Site Selection) of nuclear power projects addressed the question of knowledge or information gaps much like AECB's 1982 policy statement C-71 does. That is, they both require that such gaps or uncertainties be identified and their effect(s) evaluated.

The most relevant guideline from MOE dates back to 1975 when Ontario Hydro was undertaking site selection for a major "energy centre"(6). In effect, this guideline required a generic environmental assessment of the energy centre concept at the outset of the siting program. However, this did not present much difficulty as Hydro had considerable experience with all of the major components of an energy centre. Perhaps the most noteworthy feature of MOE's guideline was its structure based on a systematic progression from the study area level, through identification of "zones" followed by "potential sites", to detailed evaluation and selection of the best site. The guideline embodied the principle that the level of detail in data and evaluation should increase with each step towards site selection. In parallel, the environmental data on alternative zones or sites along the way should be comparable in detail. The emphasis on evaluation of alternatives, as indicated in Ontario's Environmental Assessment Act and pursuant MOE guidelines, is very relevant to concept decision-making and future site selection in the NFWM Program.

3.4 The Need to Evaluate Alternatives

In its policy statement C-71, the AECB indicates that the geologic disposal concept will be judged on its own merits(3). However, AECB requires that the rationale behind the choice of reference concept, including review of other disposal technologies, be documented and submitted along with the Concept Assessment documentation. As a contingency measure, AECL is expected to maintain a current awareness of these alternatives. This is entirely consistent with MOE's policy. More specifically, according to the concept assessment review process discussed in Section 3.1 (Table 1), alternative concept proposals would have to be considered if the current concept assessment does not end in AECB recommendation and Canada/Ontario government acceptance. Again, acceptance would be a prerequisite to site selection. Work by the Geological Survey of Canada (GSC) in the early 1970's led to the conclusion that the most appropriate geological alternative to be studied in Canada would be igneous rock formations in the Canadian Shield referred to as "plutons"(7). A pluton is an intrusive rock formation which may be thought of as an underground mountain. Since most nuclear power production in Canada will be centred in Ontario for the foreseeable future, the thrust of geoscience research in the NFWM Program has been directed at the Canadian Shield area within that province. Over 1300 plutonic formations in Ontario have been identified by GSC as potentially suitable for disposal(8). However, some effort is being devoted to examination of other geological formations such as salt, shale and even seabed formations(8,9). This effort is enhanced through ongoing exchanges of information on disposal technology developed in the US and elsewhere.

4.0 ALTERNATIVE APPROACHES TO GENERIC ASSESSMENT

As explained, Concept Assessment had to be approached in a way which would not prejudge specific locations. This was a major challenge because environmental and safety assessments usually depend on specific baseline data and, particularly, because of the large study area to be represented - i.e. the whole Canadian Shield area of Ontario. The following is a review of the different data base approaches considered by Ontario Hydro for purposes of pre-closure environmental and safety assessments. Briefly, the main alternatives considered were as follows:

(a) a single reference site;

(b) a multitude of different reference sites;

(c) a parametric approach using generalized but realistic data from the study area as a whole;

(d) a parametric approach using generalized data from regions within the study area.

4.1 Single Reference Site

It was quickly concluded that no single reference site could reasonably be expected to represent a study area as large and varied as the Shield in Ontario. An improvement was briefly considered, a "composite" reference site, which was to use environmental characteristics from various locations in Ontario. This presented difficulties in selection and integration of representative characteristics, so it was also abandoned.

It is noteworthy that the Swedish nuclear fuel safety study(10) was based on a single reference site. The Swedish study is perhaps unique in its emphasis on engineered barriers for ensuring long-term safety. This may make it less essential to use a broadly representative environmental data base than for the Canadian concept assessment which relies more on natural barriers in the long term.

4.2 Multitude of Reference Sites

A multitude of different reference sites had the attraction of better representation of the large study area. In particular, it was considered more practical and realistic for community impact assessment than a composite community or a parametric approach(11). With the multitude option, the question was whether to base each reference site on available data from real but unidentified sites, or to compose each from generalized data. Ontario Hydro certainly had the data, from its many project sites across the province, to go either way. However, this site-specific data might not be relevant to those areas on the Canadian Shield which are potentially suitable for nuclear fuel waste disposal. A look at the U.S. program indicated the potential inadequacy of a multiple reference site approach.

The US generic assessment of nuclear waste disposal(12) employed natural environment data from existing power plant sites in the midwest. Reference community data was based on three different counties in the southwest, midwest and southeast states. In hindsight, it is now evident that much of the reference environment data used for the US generic assessment was inadequate to represent the different geological areas currently being investigated(13).

4.3 Parameter Values from Whole Study Area

This option involved the use of parameter values or ranges, representing general conditions across the study area as a whole, as a reference environment data base. A major advantage seen was that it was about as far from specific site evaluation as could be imagined. A disadvantage was that it involved over-generalization of environmental conditions, obliterating the significant difference in environmental data patterns from one region to another across the Shield in Ontario. A more difficult problem was that of creating realistic reference communities using this parametric approach. However, it was becoming obvious that the parametric option had to be part of the final approach to pre-closure assessment.

4.4 Parameter Values from Study Area Regions

An improvement considered was to break the Shield study area into three regions, thus reducing the generalization concern. This allowed the regional differences to be better identified and accounted for in the assessment, but the difficulty with the reference community data remained. It was concluded that the final approach had to be a combination of options.

4.5 Final Approach to Pre-Closure Assessment

A combination of options 4.2 and 4.4 resulted in the final approach referred to as the "reference environment" approach(14). In summary, the approach involves regional data to represent the natural environment, resources, land uses and demography. More localized data, representing a number of reference community types, is used for the social environment. Table 2 summarizes the natural and social environment factors used for different components of the pre-closure environmental and safety assessments.

Figure 2 shows the extent of the study area (approximately 670 000 km^2) and its regional breakdown. The division between regions was based on a combination of administrative boundaries and obvious environmental differences. Figures 3 and 4 illustrate how we have mapped the regional distributions of actual environmental conditions in order to determine the reference conditions or parameter values for our generic assessments. The environmental data is divided into three or four value ranges which best reflect the significant differences across the regions. The proportion of total region area associated with each value range is portrayed in the circular graphs shown for each region. The size of the circular graphs corresponds to the 100 km radius of greatest

TABLE 2

OUTLINE OF MAJOR FACTORS BEING CONSIDERED IN PRE-CLOSURE ENVIRONMENTAL AND SAFETY ASSESSMENTS

Radiological & Biophysical-Resources Analyses

3 Shield Regions: Southern
Central
Northern

Regional Demography
Land Use/Capability
- Forestry & Mining
- Agriculture & Riparian Uses
- Fishing & Recreation
- Irrigation & Power
- Other Industry & Hazards
- Critical Capability Ratings (as defined by the Canada Land Inventory)

Foodchain
- Agricultural Products
- Fish & Game
- Wild Rice & Other Edibles

Biological Environment
- Aquatic Life
- Terrestrial Ecology
- Rare or Endangered Species

Physical Environment
- Air Quality
- Dispersion Meteorology
- Water and Sediment Quality
- Major Drainage Basins & Rivers
- Lake/Land Proportions
- Lake Numbers & Size Distribution
- Topography & Surficial Geology
- Hydrogeology
- Seismicity & Faults

Natural & Historical Features
Critical Non-renewable Resources

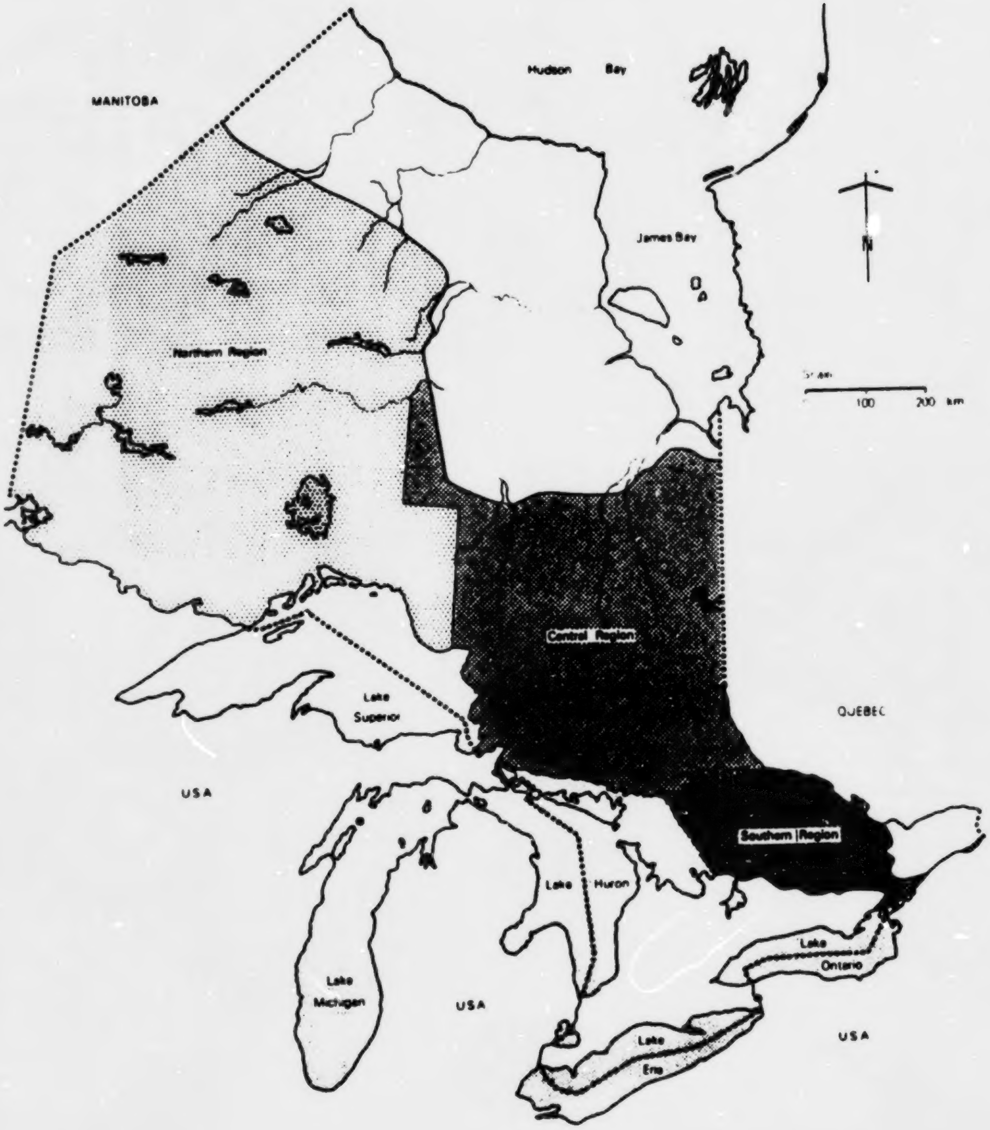
Socio-Economic & Occupational Safety Analyses

4 Community Types: Town
County
Township
Territory/New Town

Community Population
Lifestyle & Culture
Social Aspects
Education
Recreation & Tourism
Social Services
Municipal Services & Facilities
Health & Safety Services
Local Transportation & Communication
Housing & Property Values
Municipal Planning
Labour Supply
Municipal Finance
Economic Base

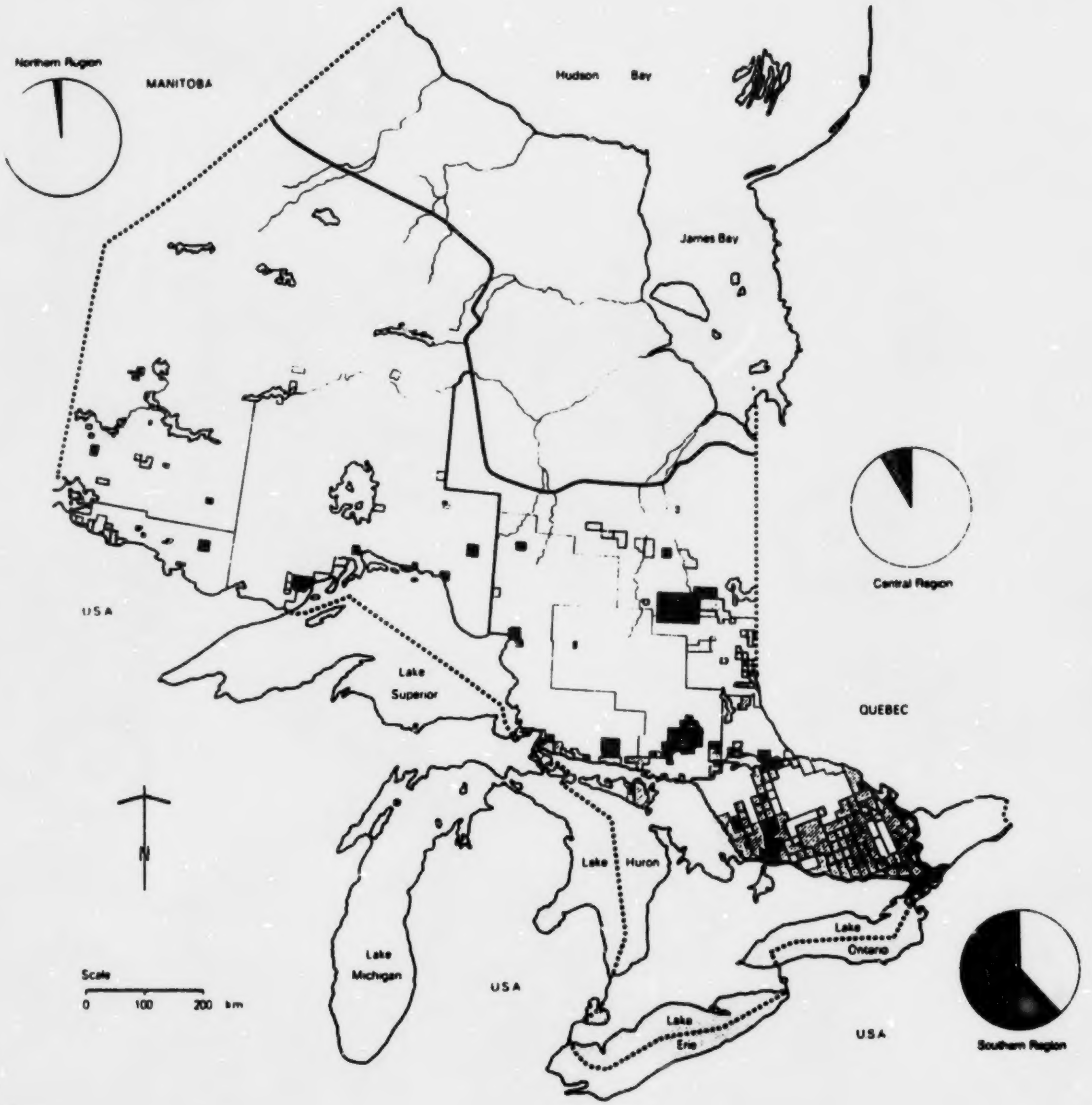
Project - Environment Interfaces

Emissions & Wastes
Visual & Noise Impacts
Land Use
Resources & Service Requirements
Workforce & Related In-Migration
Employment
Public Perceptions
etc.


MANITOBA
Hudson Bay
James Bay
N
0
100
200 km
Northern Region
Central Region
Southern Region
QUEBEC
Lake Superior
USA
Lake Huron
Lake Michigan
USA
Lake Ontario
Lake Erie
USA

Rev.: Date

FIGURE 2
Regions of Canadian Shield
in Ontario


Northern Region
MANITOBA
Hudson Bay
James Bay
USA
Lake Superior
Central Region
QUEBEC
Lake Huron
Lake Michigan
USA
Lake Ontario
Lake Erie
USA
Southern Region
N
Scale
0
100
200 km
LEGEND
(No. of People per sq. kilometre)
0 – 1.0
1.1 – 7.5
7.6 – up
Reference Environment Factor Graphs for Each Shield Region
Shield Region Division

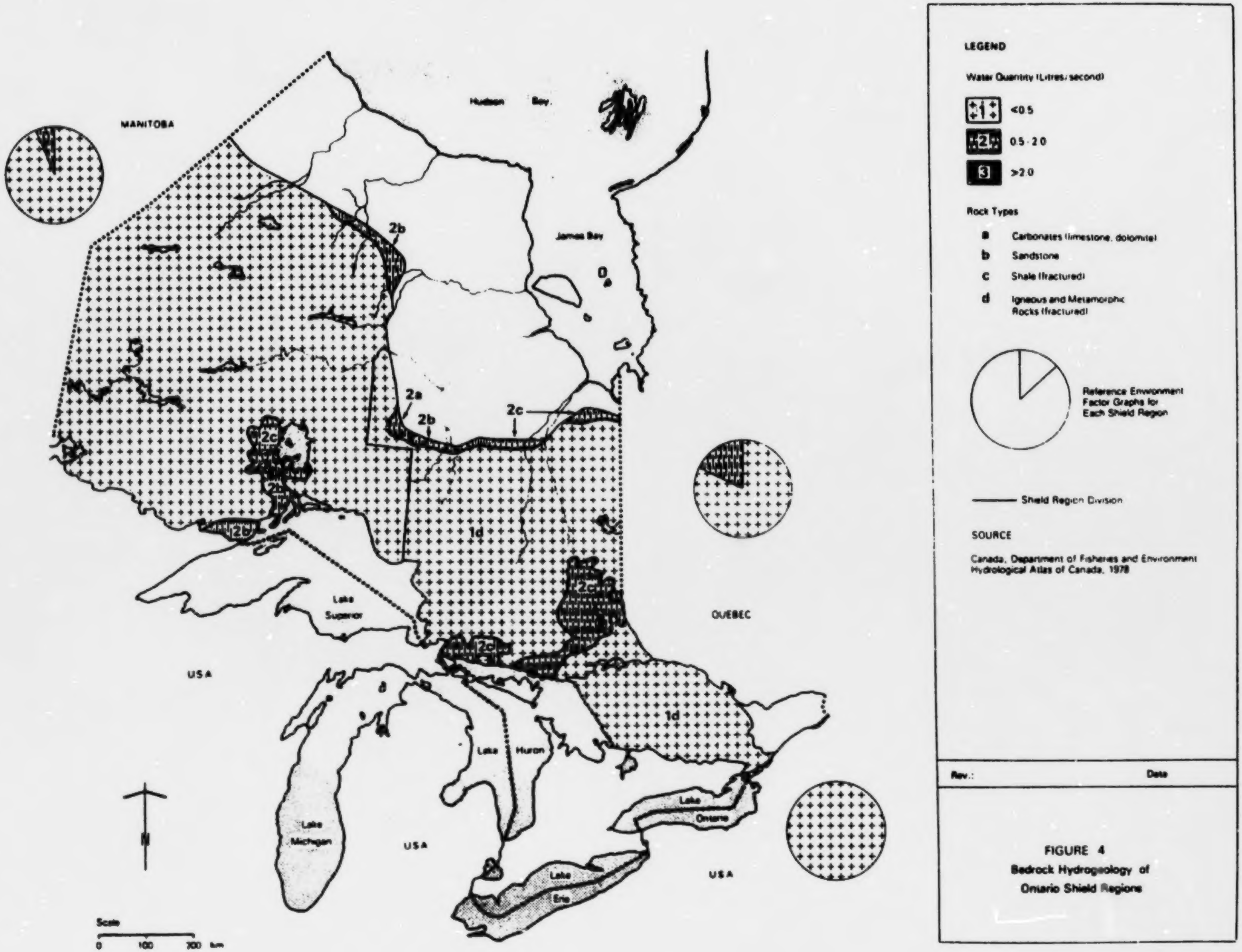
SOURCE

Statistics Canada, 1976 Census of Canada Geographic and Demographic Population, Land Area and Population Density, Catalogue 92-831, April 1978.

Statistics Canada, 1976 Census of Canada, Population: Geographic Distributions, Catalogue 92-811, October 1977.

Rev.: Date

FIGURE 3
Population Density
Across Ontario Shield Regions


LEGEND
Water Quantity (Litres/second)
1 <0.5
2 0.5-2.0
3 >2.0
Rock Types
a Carbonates (limestone, dolomite)
b Sandstone
c Shale (fractured)
d Igneous and Metamorphic Rocks (fractured)
Reference Environment Factor Graphs for Each Shield Region
Shield Region Division
MANITOBA
Hudson Bay
James Bay
QUEBEC
USA
USA
USA
Lake Superior
Lake Michigan
Lake Huron
Lake Ontario
Lake Erie
2b
2a
2b
2c
2c
2b
2b
1d
2c
2c
1d
N
Scale
0
100
200 km
Rev.:
Date
00438

SOURCE

Canada, Department of Fisheries and Environment Hydrological Atlas of Canada, 1978

FIGURE 4
Bedrock Hydrogeology of
Ontario Shield Regions

potential influence assumed for pre-closure assessment. Approximately 50 such data maps have been prepared so far, with corresponding statistics, to provide a baseline which is as broad and realistic as possible. This data format in effect gives the probability of encountering certain environmental conditions within each region and facilitates a more probabilistic (as opposed to "worst case") approach to concept assessment. Of course, it is impossible to map all of the data used for environmental and safety assessments, whether they are generic or site-specific, e.g. the majority of data used for social and community impact assessment.

Apart from regional demography and land use, social environment data cannot be generalized across regions as we have done with most of our natural environmental data. To be consistent with the reference environment approach, a range of different community types was identified from the Ontario government's municipal classification(11). The full range of municipal categories considered is listed below. However, for practical reasons, only four types were selected as reference communities for interim assessment purposes. For each of these four types, the reference communities were based on available data from real but unidentified communities. This should not be construed as an endorsement of these community types to host a nuclear fuel waste disposal centre. The addition of other community types in the data base, during later stages of concept assessment, is not precluded.

Type	Description	Preliminary Reference Communities
A	Regional municipality	
B	City	
C	Town	X
D	County	X
E	Township	X
F	Village	
G	Hamlet	
H	New Town Option (unorganized territory)	X

5.0 ISSUES WITHIN NFWM PROGRAM CONCEPT ASSESSMENT

5.1 Pre-Closure Assessment

At present, the reference community data has no statistical relationship with the regional demography or land use parameter values. The four preliminary reference communities were convenient to use because data was available from previous Ontario Hydro and AECL studies. Furthermore, they cover the low end of the population range for typical communities in Ontario (except a hamlet which might be smaller than a new company town). It is reasonable for now to assume that larger communities would have more capacity to assimilate the socio-economic impacts of a major project. Thus, while these four reference community types may not be fully representative of communities on or near the Canadian Shield in Ontario, they are definitely relevant and do provide a useful data base to begin with. We are now considering how we might improve the integration of localized community data with our geographically-referenced data, for purposes of the next interim concept assessment. One way would be to use regional demography data to determine a frequency distribution of community population sizes. One or more reference community sizes could then be identified for each region on a more statistical basis. A variation would be to incorporate economic characteristics according to the Ontario government's municipal classification system(11). Such improvements would respond to any suggestion that the current reference communities were arbitrarily chosen or deliberately biased.

Other questions which we are addressing include (a) how far to go with computer-aided analysis of community impacts, and (b) how far to go in assembling data to deal with issues that arise from public perception. With regard to community impacts, our pre-closure environmental assessment so far has employed computer models for certain aspects that are clearly suited to numerical analysis, e.g. estimating population influxes from workforce data, employment multiplier analysis, etc. However, any suggestion that social and community impact assessment should use a full system analysis method would overlook the many factors which can best be analyzed using experience (case studies) and professional judgement. With regard to the second question, we recognize that we will never get around the "not in my backyard" problem unless we are prepared to mitigate public concerns (which may not correspond with our assessment of potential impacts or risks using formal scientific methods). It is essential that the assessment adequately reconcile the difference between public perception and scientific analysis in the end.

With regard to the natural environment, we are considering the feasibility of using remote sensing data to augment our knowledge of groundwater discharge zones on the Canadian Shield. The probability of a pathway from the underground vault to a groundwater discharge zone at the surface (as opposed to a lake), as well as the probable area of the discharge soil, are important parameters for post-closure biosphere pathways analysis.

5.2 Linkage with Post-Closure Assessment

AECL found it necessary to take a different approach to post-closure assessment. Post-closure assessment must span a much longer time period than pre-closure assessment, e.g. preliminary assessment runs have extended beyond a million years(16). A fundamental problem in predicting the distant future consequence of nuclear waste disposal is the treatment of uncertainty and variability. Sources of uncertainty or variability include possible errors in measurement or determination of parameter values, the range of sites and design options to be represented, and the difficulty in characterizing the real geosphere-biosphere system using mathematical models. The latter must take into account the potential for major changes in the biosphere, and perhaps even part of the geosphere, due to natural evolutionary or disruptive processes.

AECL developed a systematic approach to analysis of uncertainties and variabilities, referred to as "systems variability analysis"(16). This approach involves characterizing the total system (underground vault, geosphere and biosphere) as a sequence of barriers to radionuclide migration. The defining parameters for each barrier (or sub-system) are expressed as distributions of values rather than single values. The biosphere sub-system is taken to include the surface environment and the shallow groundwater zone. Appropriately, this is where the pre-closure and post-closure assessment approaches are being linked, through the use of common biosphere data(17,18). AECL is considering the possibilities that radionuclides might escape the underground engineered barriers, migrate up through the geosphere and arrive at the surface at a groundwater discharge zone or directly into a lake. Thus, the improvement of our reference environment data base, to include more extensive and representative hydrology and hydrogeology parameter values, is important.

5.3 General Issues Towards Site Selection

Looking ahead, site selection will not begin until after the disposal concept has been thoroughly assessed, reviewed and approved. This is not expected to be completed until about 1991. Even then, it is not certain that site selection would be initiated immediately after concept approval. Nevertheless, it would be short-sighted to complete concept assessment without regard to procedural aspects and initial data requirements for future site selection. According to current NFWM Program planning, the initial siting requirement would be for a demonstration facility, which might eventually be developed into a full-scale disposal facility if it were shown to be suitable. We have already discussed the problem of data limitations and knowledge gaps inherent in any generic assessment. The treatment of data limitations, variabilities and uncertainties will remain essential, both to concept assessment and to demonstration of the concept. Viewing concept demonstration as a combination of indirect/predictive modelling(16,20) and later direct/physical demonstration(8,19), the NFWM Program is well organized to accomplish the transition from concept assessment to siting/demonstration.

Our geographically-referenced data base is ideally suited to "constraint mapping". This procedure might be used to identify preferred zones within the Ontario Shield study area. Beyond that, it will be important to have some well established relationships between surface features or borehole measurements and key geotechnical and hydrogeological conditions at depth, for use in potential site identification. Such surface-underground relationships need to be established through field research before the end of the Concept Assessment phase.

6.0 SUMMARY AND CONCLUSIONS

The generic and long-term nature of the concept assessment necessitates special treatment of environmental data gaps, variabilities and uncertainties in order that the concept may be judged safe and acceptable beyond reasonable doubt. This necessity is reflected in regulatory policy and guidelines.

Our "reference environment" data base for pre-closure assessment covers the whole Canadian Shield study area in Ontario. Its comprehensive scope compensates for the lack of site-specific detail. Its flexibility will allow expansion and improved integration of reference community data, if interim pre-closure assessment review indicates a need for this. Its format facilitates a probabilistic approach to generic assessment, which is important in this case where data gaps and uncertainties have to be factored into the assessment. Probabilistic analysis allows us to test the adequacy of worst case or conservative estimates when better estimates of environmental parameters are difficult to obtain. The biosphere component of the data base provides an appropriate linkage with AECL's "system variability analysis" approach to post-closure assessment. It provides biosphere parameters in the form of ranges or distributions of values rather than single values. Important improvements in this component of our data base, for both pre-closure and post-closure assessments, include more extensive and representative hydrology and hydrogeology parameter values. Remote sensing technology would appear useful to this end.

Finally, our data base is ideally suited to "constraint mapping" as a first step towards site selection.

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UTILITY SITING DECISIONS USING A GEOGRAPHIC INFORMATION SYSTEM

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Siting of generating stations, transmission lines and their supporting facilities by electric utility companies has traditionally been decided on engineering criteria alone. A better focus was needed to consider and optimize many environmental, engineering, social and cost criteria simultaneously and eliminate poor choices early in the siting process. For this reason, Southern California Edison's Geographic Information System was developed. This paper discusses the considerations that must be addressed to create a useful tool and the utilization of this tool in the 100 mW Solar Thermal (Central Receiver) Siting Demonstration.

Although primary corporate use is in the siting of all types of electrical generating facilities and their necessary offsite infrastructure, this geographic information system was also designed to be used in a truly multidisciplinary mode. Besides siting, other studies which require the modeling of occurrence, both actual and potential, and its correlation with mappable geographic situations are supported by this system. To build and manage such a system, certain design and operational techniques must be considered. Although decision results would undoubtedly vary from region to region and user to user, those items which should receive consideration are similar.

Some of the most important data characteristics which enhance the broad applicability of this system are: a wide range of data variables, e.g., slope, geology, soil, vegetation, fault locations, hydrology, wilderness study boundaries - seven of a total of ninety features and descriptions; data objectivity; extent of area covered; linkability to other data bases; modularity and compartmentalization; availability of technical support; ease of use and incorporation of the Integrated Terrain Unit method of mapping. The first consideration in which of these design factors would dominate is related to the history of the project and its initial goals.

PROJECT DEVELOPMENT

In 1972, Southern California Edison Company first looked at developing tools to systematically aid environmental assessment. Ideas from that initial study were taken by the Research and Development Department of the Advanced Engineering Department and expanded into an Environmental Sensitivity Indexing Program. The goal of this program was to rank areas affected by the siting of electric utilities for their ability to recover from that disturbance.

Because ranking is a comparative exercise, it could be based on the experience and memory of individuals familiar with the geographic area to be affected and the potential effects of construction and operation. This approach has been typically used in the preparation of environmental impact studies and in locating sites. The expertise of the scientist is immediately brought into question in any regulatory hearing. Although the ranking or modeling aspects of environmental assessment are always subjective, some regulatory indefensibility could be removed if assessment were performed on objectively classified features. A primary goal of the Indexing Program was to improve the defensibility and the licensability of a project that has minimized its environmental impacts as objectively as possible.

The first need in developing an Environmental Sensitivity Index is to develop a base of objective environmental information. Since a utility's main interest in the natural environment is how that environment affects and is affected by the company's facilities, the information must describe the environment and its changes across geographic space. The traditional form of geographic information is maps; however, a hardcopy map of all the environmental characteristics that would be necessary for a sensitivity-to-disturbance model could not be portrayed understandably on the same map. A resultant model based on such a map would have to be redrawn manually. Computer automation of mapped data solves these problems and shows where a feature exists, what the feature represents, how a feature is spatially related to other features, how many similar or dissimilar features exist and what is the extent of an individual feature and all similar features. More importantly, automation of map information makes quick manipulation, modeling and query of that data possible. Studies never before possible with hardcopy data become simple.

Immediately an even greater use of an automated mapping and analysis system of environmental data is apparent, although this expanded use would necessitate an expanded data base. Although much environmental data like geology and soil type is regularly needed by engineers for assessment of siting feasibility and cost, some additional information would be added to satisfy their special siting concerns. By building a truly multidisciplinary, multiuse data base, the traditional approach to siting, i.e., 'justify the engineer's choice' where sites are chosen on very general engineering criteria alone or because a single member of the project management team was familiar with a potential site, can be changed to one where environmental, engineering, social and cost criteria could be assessed simultaneously. The affects of changing or inappropriate criteria on siting choices could be portrayed quickly. Most importantly, project feasibility could be determined very early in the siting process before a high expenditure of funds and labor.

In 1976 these ideas became the Environmental Inventory Pilot Study which was the first of several automated resource inventories designed as siting and research tools. The characteristics and management of one of these data bases, the Eastern Mohave Resource Inventory (EMRI), will be discussed further.

DATA BASE CHARACTERISTICS

Eastern Mohave Resource Inventory

Like other SCE computerized resource inventories, the EMRI is organized by data type into individual maps of the same standardized geographic areas, e.g., all hydrologic information is stored on one map called Hydrology. All Hydrology information is divided into individual modules which correspond to single 15 minute (15') United States Geological Survey (USGS) topographic quadrangles which are publicly available. All other map overlays have a central "theme" divided into the same standard modules. See Table 1 for a complete list of all the map "themes" or types and the variables included in each type. Also see Figure 1 for the geographic areas with SCE resource inventory coverage and the glossary for an explanation of Figure 1 project acronyms.

Compartmentalization of a data base by data type and geographic subarea is important to the effective computer management of the data and the ability of the user to deal with an intelligible amount of data at one time. Central Processing Unit (CPU) time used in data handling and updating is decreased. The standard data module should be a reasonable amount of data to visually portray in full scale detail; however, automation of the entire data base (EMRI currently contains all or part of 89 modules) means that any subset of data by area can be manipulated together.

Data is stored using two linked files per data type module. First a single feature drawn on the map as a polygon, line or point corresponds to one record of a file. Each record has an identifier number plus a set of x, y vertice pairs (coordinates) which configure the feature relative to the corners of the module. A second file contains the same record identifier plus strings of codes that describe the feature. These two files - the feature Identifier/Coordinate (IDC) file and the Attribute Code Form file have such simple structures that it is easy to utilize them in non-mapping software packages like the IBM Statistical Analysis System or Design-a-Form. Thus the SCE Geographic Information Software System (GISS), the map making and analysis package, can be linked with other specialized software. It is also easy to convert other data containing locational information to SCE's Geographic Information System maps using this format. Finally, it is possible to edit feature IDC files manually, if necessary, due to the simple format.

Data areal extent is the same for all maps; however, certain areas of a region like large military reservations and national parks are excluded from all data collection. These exclusions are justified because legislation and public sentiment would make utility company use of these areas improbable. Cost savings in eliminating known siting/research excluded areas are important as well as consideration of the difficulties in acquiring the necessary information in restricted areas like military reservations. Yet some analyses are made very difficult by such exclusions. For example, if the question of how much of a certain type of habitat is threatened by development is asked, the results could indicate ecological elimination when, in fact, 90 percent of a habitat type in prime condition is in national parks and is legally protected. Ideally, coverage should be 100 percent and should be regional in extent. When that type of coverage is impossible, areas not mapped should be based on longstanding, legal exclusion of siting potential.

Feature resolution is based on polygons since lines and points mark location and do not indicate area. Polygon resolution is based on the scale at which the map was prepared for digitizing and is, more importantly, based on the importance of the feature to a regional type analysis. Also, limitations affect the software's ability to resolve polygon perimeters less than about 1.5 mm apart. Linear or point features can be drawn closer together but visual

TABLE 1

EASTERN MOHAVE RESOURCE INVENTORY

47,000 square kilometers of the Mohave Desert primarily in San Bernardino County, but includes area in Nevada and three other California counties (Riverside, Kern, Los Angeles)

MAPPING SCALE 1:62,500 or 1 inch = 1 mile (2.54 cm = 1.6 km), a 15 minute U.S.G.S. topographic quad (may be composite of 7.5 minute quads).

**INTEGRATED TERRAIN UNIT MAP (boundaries for the following information)

- Slope
- Surface Configuration
- Surface Modifier
- Landform
- Geology
    - Geologic Age
    - Rock Type
    - Geologic Formation
- Soil
    - Soil Survey
    - Soil Family/Association
    - Soil Series
    - Soil Phase
- Land Use
- Vegetation
    - Stature (overstory and understory)
    - Density
    - Cover Type
- Field Check

**CENSUS TRACT MAP (boundaries and identification number)

- 1970 Census Tracts
- 1970 Enumeration District
- 1980 Census Tracts
- 1980 Enumeration District

TABLE 1 (Con't.)

****ADMINISTRATIVE UNIT MAP (boundaries, locations and names)**

- State
- County
- City
- Unincorporated Community
- Regional Government
- Water District
- Sanitation District
- Air Pollution Control District
- Air Basin and Hydrographic Basin (Nevada)
- Air Quality Monitoring Station
- Electrical Utility District and Division

****SPECIAL PHYSICAL FEATURE MAP (locations, name and descriptive information)**

- Faults
- Age of Movement
- Epicenter (events 4.0 and greater on the Richter Scale)
  - Magnitude, Intensity, Date and Time of Largest Recorded Event
- Mine
- Volcano/Cinder Cone
- Cliff
- Pass

****SPECIAL RESERVED AREA MAP (boundaries, names and descriptive information)**

- Land Ownership (i.e., private vs. public, plus federal, state, county, etc.)
- Reserved Area
  - Status (i.e., existing vs. proposed, etc.)
  - Administrator
- Mandatory Class 1 Areas Under 1977 Clean Air Act Amendment
- California Desert Conservation Area
- Bureau of Land Management Proposed Plan
  - Wilderness Study Area
  - Area of Critical Environmental Concern
  - Multiple Use Class
  - Motorized Vehicle Access Closed Area
  - Other Reserved or Special Management Area
- California Natural Area Coordinating Council (CNACC) Natural Area
- California Department of Fish & Game Area of Special Biological Importance

TABLE 1 (Con't.)

****HYDROLOGY MAP (boundaries, locations, names and descriptive information)**

- Type of Water Source
- Stream Course Order
- Periodicity of Water Source
- Flood Prone Zone
  - U.S. Geological Survey
  - National Flood Insurance Program
- Watershed
- Hydrologic Subunit (valleys)

****INFRASTRUCTURE MAP (locations, names and descriptive information)**

- Type of Infrastructure
  - TRANSPORTATION
    - Road (freeways to dirt)
    - Railroad
    - Airport
  - ENERGY
    - Transmission Line
    - Transmission Substation
    - Generating Station
    - Power Site
    - Bureau of Land Management Corridor
  - COMMUNICATION
    - Telephone Line
    - Microwave Tower
    - TV/Radio Tower
    - Tracking Station
  - NAVIGATION AID (Marine and Aeronautical)
  - CONVEYANCE OF MATERIAL
    - Aqueduct
    - Pipeline
    - Canal
  - OTHER
    - Rest Area
    - Inspection Station
    - Dam
    - Dikes/Levees
- Ownership
- Subunits (i.e., # of tracks, lines, pipes)
- Measure (i.e., diameter, length, kV)
- Scenic Highway Designation
- Status (i.e., existing vs. proposed, etc.)

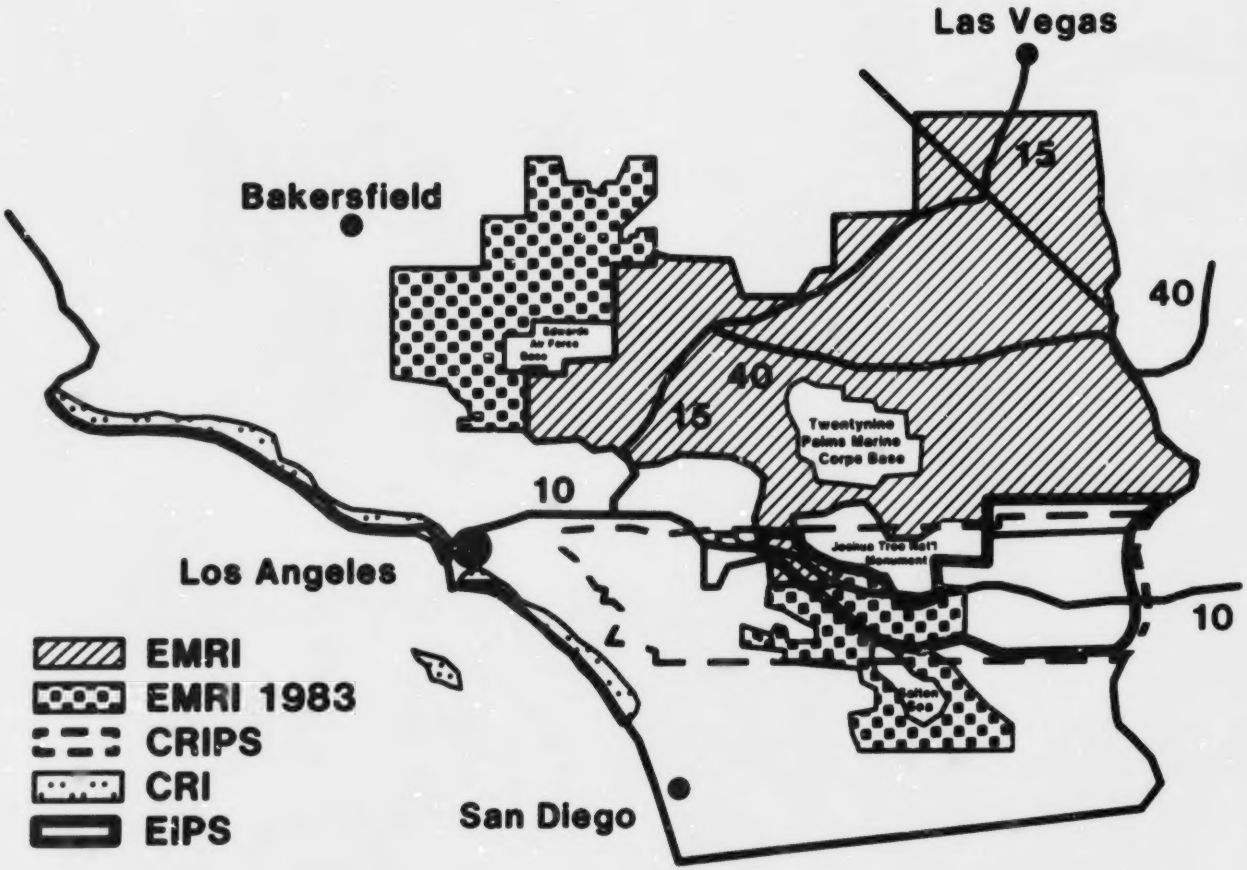
Las Vegas
Bakersfield
Los Angeles
San Diego
Edwards Air Force Base
Twentynine Palms Marine Corps Base
Joshua Tree Nat'l Monument
Salton Sea
15
40
10
15
40
10
EMRI
EMRI 1983
CRIPS
CRI
EIPS

FIGURE 1

BOUNDARIES OF ALL SOUTHERN CALIFORNIA EDISON CO. RESOURCE INVENTORY PROJECTS IN SOUTHERN CAIFORNIA AND NEVEDA

See glossary for explanation of acronymns.

separation becomes a problem. For the EMRI the polygon resolution is 4.5 hectares. Polygons of special interest smaller than this limit are represented by points on all maps except Integrated Terrain Units where they are not shown. If a unique area is less than 4.5 hectares, it could be avoided during site-specific studies following the regional computer analysis.

Data classification uniformity is important to the flexibility of use as well as the expandability of the data base. In the deserts of Southern California and Nevada, information is sparse; therefore, hierarchical data classification is effective with the lowest (most general) level of information available for the entire resource inventory. Some areas will have more specific information which can easily be incorporated into the same hierarchical data classification at a higher level of classification. As more specific information is available, it can be added without affecting the more general data already coded. Data should never be generalized, but the more general level of classification should always be given. Any hierarchical classification system should also be expandable to geographic areas beyond the original study area. Finally, the classification should be based on multiple uses, not simply the desires of a single specialist. Above all, the information classified should be objective in nature. For example, it is appropriate to map soil type, slope, vegetation, etc. - factors related to "range carrying capacity" - which are important to the modeling of many types of impacts. It is inappropriate to map "range carrying capacity" - modeled (subjective) results which could easily change depending on the changing scientific and legislative ideas on how to determine carrying capacity.

Any data base as large as the EMRI with seven data layers currently covering 24,000 square miles should attempt to organize data of maximum credibility and temporal stability. There are some data items which are very important but do not fall into either of these categories nor are they objective in nature. Agency management plan boundaries are of this nature; however, some of this difficulty is offset because all of that type of information is found on a single data layer, Special Reserved Areas and the feature description, i.e., the area's status, is usually all that changes. All of these concepts of data classification and organization were considered when the EMRI was designed.

Summary of EMRI Characteristics. In designing the EMRI so it could be truly a multidisciplinary, multiuse siting and research tool, the ideas of data compartmentalization; simple file format for software linkage, data conversion and file updating or correction; data extent; area exclusion; polygon resolution; data objectivity; hierarchical classification; and classification expandability were all considered.

INFORMATION SOURCES

In order to achieve the data base design goals, the appropriate information must either be available or be able to be constructed from other readily available secondary sources. For a region so large and remote as the Mohave Desert, data quality and quantity is low. The best source of information on many variables over a large geographic area is aerial photography; however, the photos tend to be several years old and the coverage of large scale photos is practically non-existent or in private ownership. Color infrared transparencies are available at a 1:130,000 scale which is essentially planimetric.

The photos are also available with overlap so that stereoscopic interpretation is possible. In a desert area with a relatively low rate of change with time and low relative density of vegetation, these photos are the main source of interpretable data. For any type of feature expressed on the ground's surface, the photos are both a primary source of data and a secondary check for other data sources. The photos are the best aid to relocate features which have been accurately described but poorly located cartographically.

What makes the use of photos special for all Southern California Edison resource inventories is their utilization to develop Integrated Terrain Units. These maps show the boundaries of homogeneous areas on the earth's surface which are directly related to the corresponding areas of aerial photos which show the boundaries of zones of homogeneous color, pattern and texture. These resultant polygons are habitats classified to the level of detail and for the types of variables which show up on the aerial photographs. Although the aerial photos will indicate change, the significance or meaning of that change cannot be recorded without further information. The source of this data is either specialized collateral, e.g., a geology field map or field sampling/reconnaissance e.g., desert vegetation studies.

The use of Integrated Terrain Units to store physical geographic information solves the difficulties of interpretation, data inaccuracy, data management and automation inherent in the use of parametric (non-integrated) data overlays. Geology, soil, percent slope and other terrain features are interrelated and tend to change at or very near the same location so that a change in color, pattern and texture on an aerial photograph shows a change in one to many terrain features. If each component that contributes to that photographic boundary were automated separately from existing single parameter maps (which vary greatly in scale, accuracy and original purpose), the resultant map would be essentially useless.

Figure 2 shows the use of information from the Integrated Terrain Units in conjunction with linear data from the Hydrology overlay and point data from a special overlay, Cultural Resources. This figure illustrates the ability to use or create single, parametric data from the Integrated Terrain Unit and the ability to model potential occurrence, e.g., previously unsampled areas with a high probability for archaeological sites. This modeling effort also shows useful- ness of data compartmentalization: the model does not have to manipulate all the data available but only those data items which drive the model.

Other map types like Administrative Units are nothing more than the copying of the most accurate, most current data. These maps only involve interpretation where the information on boundary location is not already mapped.

With good design of the data base and appropriate data sources reinterpreted to maximize the effectiveness of automation, certain improvements in the siting process could be realized. See the following list for positive benefits of utility siting using a geographic information system.

BENEFITS OF USING A GEOGRAPHIC INFORMATION SYSTEM

Siting

There is increased effectiveness in choosing a licensable siting area because a geographic information system:

- provides high quality, standardized data for remote regions where this type of data is usually not available.

Use of Resource Inventory
Data and Analysis Techniques
to Model Archaeologic
Potential

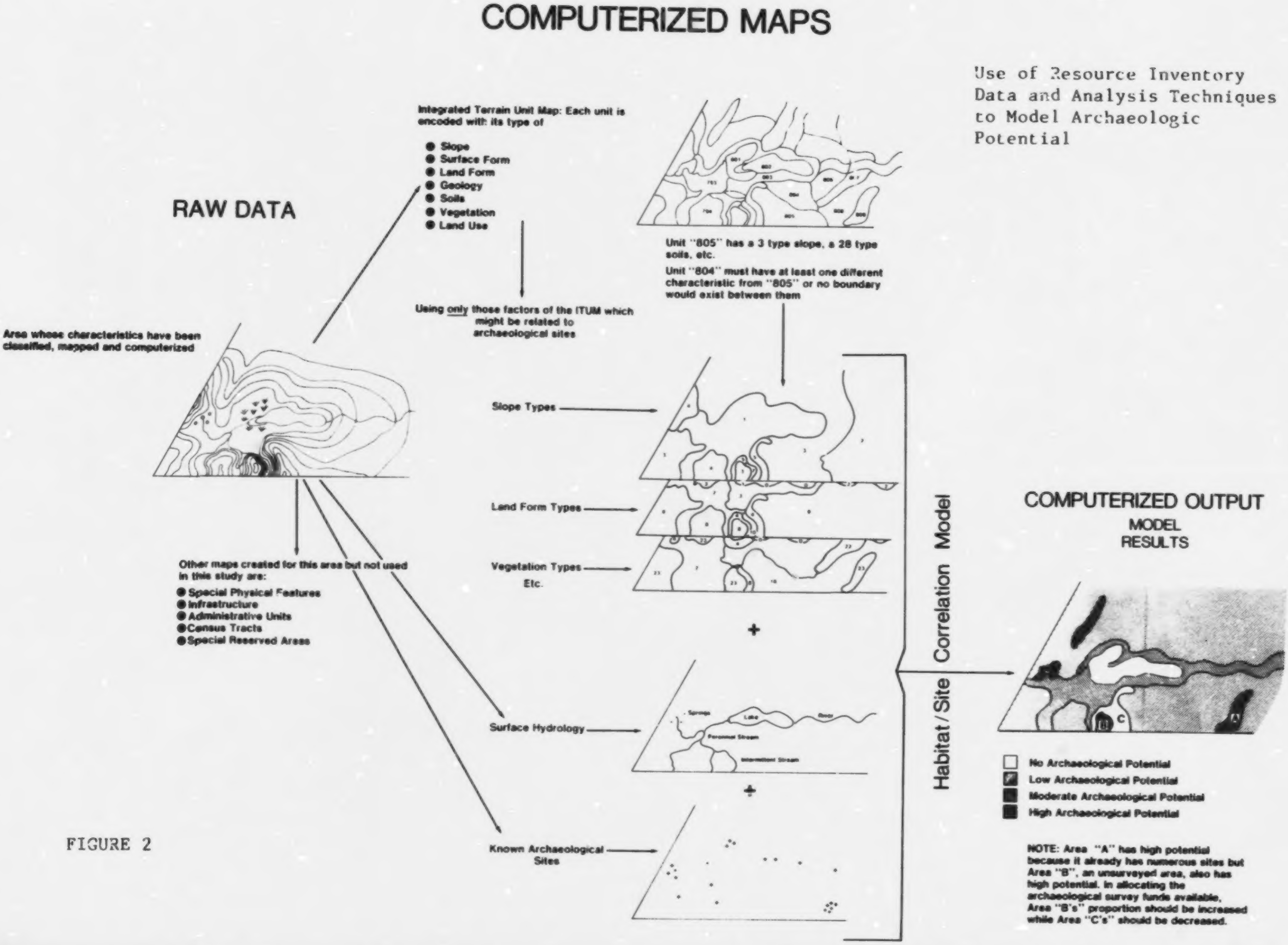
COMPUTERIZED MAPS
RAW DATA
Area whose characteristics have been classified, mapped and computerized
Integrated Terrain Unit Map: Each unit is encoded with its type of
● Slope
● Surface Form
● Land Form
● Geology
● Soils
● Vegetation
● Land Use
Using only those factors of the ITUM which might be related to archaeological sites
Unit "805" has a 3 type slope, a 28 type soils, etc.
Unit "804" must have at least one different characteristic from "805" or no boundary would exist between them
Other maps created for this area but not used in this study are:
● Special Physical Features
● Infrastructure
● Administrative Units
● Census Tracts
● Special Reserved Areas
Slope Types
Land Form Types
Vegetation Types
Etc.
+
Surface Hydrology
Springs
Lake
Perennial Stream
Intermittent Stream
+
Known Archaeological Sites
Habitat / Site Correlation Model
COMPUTERIZED OUTPUT
MODEL
RESULTS
A
B
C
☐ No Archaeological Potential
▨ Low Archaeological Potential
■ Moderate Archaeological Potential
■ High Archaeological Potential
NOTE: Area "A" has high potential because it already has numerous sites but Area "B", an unsurveyed area, also has high potential. In allocating the archaeological survey funds available, Area "B's" proportion should be increased while Area "C's" should be decreased.

FIGURE 2

- is a multidisciplinary approach to choosing site areas (complies with the law).
- identifies all alternate siting areas having equivalent constraints and opportunities.
- locates new siting areas and assesses those chosen by other means.
- deals with changing political and regulatory attitudes without redoing the data.
- identifies "cost" to acquire a license early in the siting process.
- does a generalized analysis of any geographic location.
- sites any type of facility.

There is increased effectiveness in acquiring a project license from regulatory agencies because a geographic information system:

- provides an easily understandable approach to siting.
- documents the siting process and siting criteria.
- increases the persuasiveness of data presentation while reducing the cost.
- clearly shows why "other" sites were not chosen.
- encourages siting criteria to be consistently applied.
- complies with techniques accepted and appreciated by regulatory agencies.

There is increased effectiveness in allocation of budgets and utilization of manpower because a geographic information system:

- allows data to be used for a variety of purposes without requiring new data acquisition for each purpose.
- encourages data use and reuse.
- preserves data beyond the lifetime of one project.
- preserves data beyond the employment of any individual.
- provides a tool to increase the usefulness and expertise of new personnel.
- reduces the time needed to make an initial analysis.
- allows updating of data on an ongoing basis.
- eliminates the "fire drill" approach to regional impact assessment.
- provides data on the surrounding area to a site, i.e., non-site impacts are assessable without additional data collection.
- determines the relative importance of various features to license acquisition.
- allows use of any subset of data.
- shows where the siting $'s can be most successfully spent, i.e., where to do specific studies.
- allows tailoring of the data base and supporting software to special one-time users.
- eliminates repetitious data collection for projects covering the same or overlapping geographic areas.

For the environmental aspect of siting (similar effects are possible for other disciplines), there is increased predictive modeling success of utility impact on the environment because a geographic information system:

- provides a framework for the extrapolation of site-specific biological/ecological information across a large region.
- shows habitats.
- shows habitat diversity in a given area.

- provides a framework for prediction occurrence of resources legally required to be protected in previously unsurveyed areas.
- shows unique habitats and their amount of current protection, i.e., the conjunction of habitat types and specially reserved or managed areas.
- provides a correlation method for man-made resources whose location is influenced by the "natural" environmental, e.g., cultural resources like archaeological sites and artifacts.
- provides a basis for discussion of mitigation needs or their lack with various regulatory agencies (and the potential for success).
- shows the most desirable areas for use versus preservation.

THE GEOGRAPHIC INFORMATION CENTER

While good data base design and the appropriateness of software analysis programs are crucial to realize the benefits listed above, these two goals are pointless if the system developed does not have the appropriate in-house support. In this case, "support" has two very distinctive meanings. The first is technical support and the second meaning includes jurisdiction and budget stability. The first meaning can be achieved rather easily if the second type of support is available.

Early in the development of the resource inventory program, it was rather naively assumed that a software system could be developed that was entirely "user friendly" and that all users of the system's data and analysis capabilities could run the programs with little or no assistance. While many user aids were developed for this goal, the mapping/analysis portion of the system is user tolerant for those people who use the data frequently. Rather than try to make computer technicians of the infrequent engineer, sociologist or archaeologist user; training is available only on those programs which output results. Another package called Design-a-Form was linked to the GISS so that a report on any feature mapped in any resource inventory would be available on any terminal with IBM mainframe access throughout the company. All the necessary tasks of data and software maintenance and enhancement are done by specially trained technicians which form the Geographic Information Center. Projects are also completed by this group for those needing services both in-house and from non-company requestors. One type of support need has been fulfilled.

The second type of support has been more difficult to obtain. While this tool was in a developmental state, a sufficient budget was available from Research and Development; now that the tool's use has been demonstrated, it is no longer appropriately under the jurisdiction of R&D. Two other sources of primary support have also become scarce coincident with the system's completion; less funds are generally available throughout the company so that groups with specialized requests cannot fund these requests and the R&D budget is insufficient to support these requests even though many require additional project research or development. Secondly, Southern California Edison is doing little siting. Relative to these two points is the lack of jurisdiction given to the Geographic Information Center to perform all computerized mapping/analysis work for the company or any corporations requesting siting information and assistance from SCE. Plans have been made to transfer this program to a new group in Advanced Engineering called Project Development. Although the siting aspects of this program will be used, it is still uncertain if the full potential of the system will be realized. Much of this type of support uncertainty could be eliminated if jurisdiction is agreed to prior to project initiation and contingent upon the satisfactory building of the data base, the capabilities of the geographic analysis software and the support of a technical group. The tool must be backed by the corporation's upper management from its start to eliminate middle management support ambivalence. Also due to a relatively long leadtime needed to develop a working geographic information system, the corporation must be able to take a longterm approach to funding and personnel working on the data base.

If corporate jurisdiction is not possible at the program start and no siting projects are planned for regions where data has been gathered, then a demonstration project can be a teaching tool to show the value of the program to those assigned to complete a siting study. One potential result is a change in how siting is completed. Instead of maintaining a generalized bank of sites, siting can be done to consider the unique properties of various technologies. Siting can also be done independent of a specific project and changed as necessary to allow for technological enhancements and regulatory changes. Sites resulting from these analyses could be banked for the use of the utility or in the absence of utility capital, "sold" to third party entrepreneurs who would develop the project for electricity resale to the utility. The following project is typical of a technology-specific study completed independent of an existing project.

100 mW SOLAR THERMAL CENTRAL RECEIVER SITING DEMONSTRATION

This demonstration was completed to achieve a variety of goals: 1) to familiarize in-house personnel with the type and amount of automated geographic information available for their use, particularly the contents of the Eastern Mohave Resource Inventory; 2) to transfer the capabilities to access and utilize the data of the EMRI through the SCE Geographic Information Software System; 3) to involve all the in-house staff who usually contribute to the assessment of chosen sites in a new technology that integrates all their concerns simultaneously; 4) to show Edison personnel how to systematically convert subjective assessment into quantifiable or qualifiable criteria for siting, and 5) to show the Geographic Information Center the level and timing of support required of them during a major siting effort.

Response to the demonstration was gratifying. Eleven groups in five departments sent a total of twenty-five representatives who supplied input in a series of workshops and questionnaires. A study area of major interest to the siting group was chosen. The total demonstration area was limited to 2600 km^2 to facilitate processing and simplify the number of different data categories that each siting expert would have to assess.

The proposed methodology was outlined in the first workshop and received approval. This methodology was designed to result in capable sites while showing the potential of the data base and its supporting software. The approved approach included four phases, each succeeding phase focused on a smaller geographic area resulting from the previous phase. First a study scope was developed which included choosing the subregion of the entire Eastern Mohave Resource Inventory which would be used in the demonstration and deciding which data layers were applicable to the siting of a 100 mW solar thermal central receiver.

Phase 2 was the Regional Screening. For the greatest defensibility of methodology, exclusion screening was chosen. The result, candidate areas, would remain after a set of explicit exclusionary criteria was applied to the study area. The majority of the demonstration effort was done on Phase 2 to teach the siting experts how to translate their criteria into computer-understandable commands. An example of a criterion used is that an acceptable candidate area must be greater than 2.4 kilometers distant from a residential area. The original criterion was 8 kilometers but this criterion proved overly restrictive since very small parcels of "rural residential" landuse are scattered over the Mohave Desert. With a distance of 8 kilometers, the entire area was excluded on a single criterion that reflected a desirable condition but not a truly exclusionary one. The flexibility and speed of computer analysis was immediately apparent as the overly restrictive criterion was replaced. The value of performing sensitivity analysis on the effects of individual criterion was underscored.

Eventually, twenty-four criteria were retained for exclusion screening. These criteria were grouped into four issue themes: cost, engineering, environmental and health/safety. Criteria were applied to selecting viable locations for both the generating station itself and its "umbilicals", i.e., the necessary access roads, transmission lines and in one scenario, water pipeline. As a parallel effort, criteria were developed for other technologies of interest to Edison, e.g. coal-fired power plants.

For the purposes of this demonstration of system potential, Phase 3 involved the selection of candidate sites within the candidate areas. Personal judgment was used to select a variety of site types having a minimum of 512 contiguous hectares for the generating station location. Although many configurations and more sites were possible, nine were chosen for evaluation in Phase 4.

A tradeoff analysis or, more specifically multiattribute preference functions, was used to evaluate the candidate sites. Although this study was a demonstration, several new, capable sites were discovered.

To improve response time and hone analysis skills, this study was duplicated on a more remote and larger (2400 km) section of the Eastern Mohave Resource Inventory for which there was little personal information available. A field study of the resulting candidate areas proved the accuracy of this tool when used in a siting study.

This demonstration was successful both in terms of locating several regionally acceptable sites and in demonstrating how this technology can contribute to the site selection process.

SUMMARY

The potential of a geographic information system used for utility siting decisions and special modeling studies is dependent on its design characteristics, information quality and available technical support. Whether a mechanistically successful system is ultimately useful is dependent on political support within the corporation. All of the these points must be planned for to build a truly beneficial tool.

GLOSSARY

EMRI - Eastern Mohave Resource Inventory

EMRI 1983 - Regional Additions to Eastern Mohave Resource Inventory

CRIPS - Cultural Resource Inventory Pilot Study (Riverside County, CA)

CRI - Coastal Resource Inventory

EIPS - Environmental Inventory Pilot Study

10, 15, 40 - Interstate 10, 15 and 40 locations

SITING ENERGY PROJECTS: THE NEED TO CONSIDER CUMULATIVE IMPACTS

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ABSTRACT

Although regulations for implementing the National Environmental Policy Act identify the need to assess cumulative impacts (i.e., incremental impacts of overall development in the affected region) associated with federal funding or approval of major actions, most federal studies devote minimal attention to this topic. A review of environmental impact statements on energy projects found that most analyses of cumulative impacts were written in very general terms, presented few data to support these general conclusions, and appeared to have had little influence on the selection of the environmentally preferred site. Nevertheless, analyses of cumulative impacts can and should be undertaken as an important part of the evaluation of project impacts. We include recommendations on the types of information and analyses that should be used in evaluating the cumulative effects of siting energy projects.

INTRODUCTION

In assessing environmental effects related to siting a new energy project within a particular region, careful consideration should be given to evaluating a project's contribution to cumulative impacts of current and planned developments. In the United States, the implementing regulations for the National Environmental Policy Act of 1969 (NEPA) (CEQ 1978) specifically require that an assessment of cumulative environmental impacts be included in an environmental impact statement (EIS) on any project involving approval and/or funding by a federal government agency. Most EISs include the results of siting studies in sections evaluating potential impacts of locating the proposed project at alternative sites. Our experience with preparing and reviewing EISs on energy projects suggests that analyses of cumulative impacts are rarely included and, when present, are often cursory descriptions of possible effects that contribute little to the overall understanding of cumulative impacts.

This paper presents the results of a review of recently prepared EISs on energy projects that we undertook to determine (1) how frequently cumulative impacts are discussed and (2) what analytical approaches are used to address cumulative impacts. On the basis of our review, we present a set of recommendations on how to approach the assessment of cumulative impacts.

BACKGROUND

Under NEPA federal government agencies are required to prepare an EIS on any federal action that would significantly affect the quality of the human environment. Typical federal actions that require an EIS include the issuance of permits and licenses for constructing and operating an energy facility and the funding or granting of loan guarantees for an energy project. Federal agencies may authorize certain states to run permit programs, but even in this case, many states require the preparation of a state EIS equivalent.

The Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of NEPA (CEQ 1978) clearly state that an EIS should address cumulative environmental impacts. State regulations may have similar requirements. In determining the scope of an EIS, federal agencies are directed to consider

> "cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement." [Sec. 1508.25(a)(2)]

"Cumulative impact" is defined in the regulations as,

> ". . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (Sec. 1508.7)

The CEQ regulations also state (Sec. 1508.27) that determination of the significance of an action requires consideration of both the context in which the action takes place and the intensity (i.e., severity) of the resultant impact. In evaluating the intensity of an impact, one factor that should be considered is

> "Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or breaking it down into small component parts." (Sec. 1508.27(b)(7)

Finally, in defining the term "effects," the regulations state that

> ". . . effects include ecological . . . aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. . .." (Sec. 1508.8)

Clearly, cumulative effects should be considered during the preparation of an EIS, and one should expect to see them addressed in all project impact statements.

APPROACH

To determine how various federal government agencies evaluate cumulative impacts, we reviewed a group of 81 EISs (Table 1) prepared by 13 federal government agencies between 1977 and 1983. Although most of the EISs we chose for review dealt with the siting, construction, and operation of energy projects (65%) or energy resource developments (14%), we also included a sample (21%) of nonenergy project EISs to ascertain if cumulative impact assessments were handled any differently. In evaluating each document, we looked first for general sections on cumulative impacts and then reviewed specific sections on impacts to terrestrial and aquatic ecological resources. We did not review impact sections for disciplines other than ecology (e.g., the socioeconomic or air quality sections) but assumed that, in general, failure to find specific reference to cumulative impacts in either general sections or the specific sections on ecological resources indicated that cumulative impacts were not considered a central part of the EIS analysis.

RESULTS

Twenty of the EISs reviewed (25%) contained general sections on cumulative impacts and/or specific discussions of such impacts to aquatic and/or terrestrial ecosystems (Table 1). Many of these documents were prepared by the U.S. Department of the Interior for projects involving the regional development of coal and lignite resources (e.g., U.S. DOI 1979, 1981). The two U.S. Department of Energy EISs we reviewed that dealt with conversion of oil- and gas-fired power plants to coal-burning facilities also discussed cumulative impacts, but mostly in relation to air quality and solid waste disposal issues (U.S. DOE 1982a, 1982b). A few of the EISs on transmission lines and hydroelectric projects also addressed cumulative impacts for some issues.

We found that most cumulative impact analyses consisted of narrative descriptions supported by few, if any, quantitative data. When quantitative data were used, tabular summaries were usually presented showing estimates of land area, vegetation area, and wildlife habitat area disturbed (U.S. DOI 1980a,b, 1981, and U.S. EPA 1981). Quantitative data on water resources were not encountered frequently, but estimates of cumulative water consumption and water depletion were made in a few documents. In addition, estimates were included of changes to salinity levels in water downstream from project development, reflecting the net effects of a variety of developments (U.S. DOI 1980a, 1983).

TABLE 1. IMPACT STATEMENTS REVIEWED FOR CUMULATIVE IMPACT ANALYSES

Project type	Number EISs reviewed	Sponsoring agencies*	EISs having cumulative impact analyses
Coal/lignite power plants	21	BuRec, COE, EPA, FERC, REA	3
Regional coal/ lignite resource development	10	DOI	9
Transmission lines and pipelines	9	REA, DOE, FERC	3
Hydroelectric/water supply	12	BuRec, DOI, FERC,	3
Conversion from oil/ gas to coal	2	DOE	2
Uranium mills	1	NRC	0
Nuclear power plants	9	NRC	0
Nonenergy water projects	5	COE, DOI, SCS	0
Highways	9	FHWA	0
Other	3	DOI, FWS	0
Total	81		20

* BuRec - U.S. Bureau of Reclamation; COE - U.S. Army Corps of Engineers; DOE - U.S. Department of Energy; DOI - U.S. Department of Interior; EPA - U.S. Environmental Protection Agency; FERC - Federal Energy Regulatory Commission, FHWA - Federal Highway Administration; FWS - U.S. Fish and Wildlife Service; NRC - U.S. Nuclear Regulatory Commission; REA - Rural Electrification Administration; SCS - Soil Conservation Service

Narrative descriptions of cumulative impacts to terrestrial and aquatic resources frequently identified critical resource features [e.g., winter range for deer and elk (U.S. DOI 1980a, 1983)], but failed to analyze the relative impact of the proposed project in the context of overall regional development and, therefore, cannot be considered as adequately addressing the requirements of NEPA.

Other qualitative analyses included discussions on vegetation reclamation after disturbance (U.S. DOI and MDSL 1980), cumulative soil disturbance (U.S. DOI 1979, 1980a), air quality impacts to vegetation (U.S. DOI and MDSL 1980), and effects of secondary or indirect impacts associated with the project or other developments. In most cases, these discussions simply identified the problem area without suggesting any alternatives or solutions. In one case, an agency developed a cumulative impact analysis that emphasized the cumulative benefits of project development on regional resources (U.S. DOE 1983), leaving the reader to come to his own conclusion as to whether there were any adverse cumulative impacts.

The results of our survey showed that only a small number of EISs contained any mention of cumulative impacts, and, of those that did, few analyses of cumulative impacts approached the standards of the CEQ requirement. It was clear, however, that some agencies have given consideration to developing regional perspectives that consider cumulative effects of development, at least for a particular resource.

CONCLUSIONS

There is little doubt that cumulative impacts can be significant. For example, our landscapes are now crisscrossed by roads, pipelines, and transmission line corridors. Impacts of additional facilities clearly have significant cumulative, if not individual, effects. To an extent, cumulative effects may be considered implicitly when alternatives that include use of existing routes are considered. Without more thorough analyses, however, the extent of additional cumulative impacts cannot be known or mitigated. Similarly, although multiple small hydro projects may appear individually benign, when a group of such projects is considered in the context of disappearing free-flowing aquatic resources and on a basin-level or regional basis, significant, adverse cumulative impacts could occur. The nature and extent of such effects can and should be considered in siting and routing decisions.

Considerable improvement can be made in the manner with which federal agencies respond to the CEQ requirement that cumulative impacts be addressed in an EIS. The most useful analyses we found were those dealing with development of energy resources (e.g., coal) for a particular region. Even these analyses tended to be narrative in form and presented little quantitative information on terrestrial and aquatic resources. Often, a well-developed data base on regional development and resources is not readily available, and an agency must face the problem of assembling scattered existing information in a meaningful way to evaluate cumulative impacts associated with the proposed project.

RECOMMENDATIONS

In situations where a series of related actions in a particular region is being considered (e.g., leasing coal reserves within a given coal region), a federal agency may wish to prepare a tiered set of EISs as recommended in 40 CFR 1502.4 (CEQ 1978). A regional EIS would be appropriate to address such related developments and their cumulative impacts, with additonal specific project EISs prepared to assess site-specific impacts. These latter EISs would incorporate the regional analysis of cumulative impacts by reference, perhaps refining it if additional information has been developed for the project in hand.

More commonly, a federal agency is faced with considering the siting of a single project within a region in which the development of projects sponsored by other groups is occurring. In preparing an EIS in this situation, the agency must compile a data base on relevant regional development activities and their environmental effects. In some cases, state, regional, or local land and water resource planning agencies may have such a data base available, but more often the needed information is scattered, unavailable, or difficult to compare to other data.

To develop a reasonable assessment of cumulative impacts, a federal agency must confront the following problem areas in scoping the study: (1) defining the geographic area to be considered, (2) identifying activities within the impact area that are relevant and should be considered, (3) developing baseline data on regional resources and project impacts, and (4) preparing a reasonable methodology for evaluating individual and combined project effects. During the scoping process for an EIS, the agency should solicit input from the public and from local, regional, and state resource agencies so that there is some consensus on the approach and the best available data are identified.

We recommend the following steps to develop a meaningful assessment of cumulative environmental impacts:

(1) Define the resources to be considered in the study

Because it is generally not feasible to develop detailed data on all possibly affected resources, the focus of the analysis should be on those that are identified in the scoping process as being of most concern to the public and resource managers. Important elements of this step are to hold public meetings within the affected region and to solicit input on the type of analysis to be done. The agency should attempt to have interested parties reach a consensus on the most important aspects of the study, if possible.

(2) Define the geographic area of concern (i.e., impact region)

Each resource to be studied should be considered and the impact region for each may have to be defined somewhat differently. For example, the geographic region for terrestrial and aquatic resources may be best defined on the basis of a single drainage basin, whereas consideration of socioeconomic effects may require study of a much larger area delineated in terms of political, rather than natural, boundaries (e.g., a county or regional planning area). The more clearly the individual resource area is defined, the more meaningful the analysis will be.

(3) Identify relevant development activities

Some of the cases we examined in our review of EISs restricted their study to projects that were similar or closely related to the proposed project. For example, regional coal studies were primarily concerned with other leasing or mining activities, while some water project studies only examined other water projects on the same stream system. Such restrictions may be necessary because a broader approach may not be economically feasible or because the only data available deal with a limited group of projects. In the initial phases of the study, however, an agency should consider a broad spectrum of activities for possible evaluation and then develop a defensible rationale to narrow them down to a meaningful and feasible group for analysis.

(4) Collect baseline data on resources and project effects

One problem that must be considered initially is whether the study should address effects of past development activities. Such information may be useful in defining the current status of each resource, in predicting impacts of similar projects, and in developing mitigation measures which could compensate for past environmental problems or assist in planning mitigation measures that would avoid similar problems. Realistically, most federal agencies do not have sufficient time or financial resources to include any detailed examination of past resource development, but even a limited examination may greatly assist in understanding potential cumulative effects.

(5) Develop a methodology to establish a framework for comparison

A methodology should be developed that will allow existing and proposed development activities to be considered in a common framework within each discipline. For example, in the area of aquatic ecology, the common framework within which to assess both existing stresses and the additional impacts of proposed development might be reductions in fish populations. Similarly, impacts to terrestrial vegetation from a variety of existing and proposed sources of air pollutants might be expressed in terms of the contribution of each source to the decline in productivity of some agricultural crop. In this way the cumulative effects of a number of diverse impacts to a particular resource can be considered in a unified, quantitative way.

Once the common denominator used to quantify impacts for each discipline or resource has been selected, the most logical method of combining effects of the different projects should be determined. Cumulative impacts from different sources can act upon a resource in an additive, synergistic, or antagonistic fashion. For example, if existing project A discharges copper to a waterbody and proposed project B would discharge zinc, the cumulative effects in terms of toxicity to fish would be expected to be synergistic (i.e., greater than the sum of the individual toxicities). On the other hand, toxic materials discharged into a waterbody may be sequestered or inactivated by suspended silt which enters the water from upstream erosion. In this case, cumulative effects would be less than expected due to the antagonistic interaction of the new stress (discharge of toxic material) with an existing stress (improper land use practice). In the absence of specific knowledge on synergistic or antagonistic interactions, an additive approach is probably the best because it can be readily understood and may be the most common type of interaction. If other ways of combining data are used, these results can profitably be compared to the results of a simple additive approach.

Once impacts from each project have been combined, the significance of cumulative effects can be determined. Major contributions to the overall impact from specific projects can be identified and used to develop appropriate mitigation strategies or to stop project approval. Impacts can be reassessed by taking mitigation strategies into account to determine if adverse effects have been reduced to an acceptable level.

The approach outlined above is amenable to many types of projects, clearly presents the assumptions underlying the analysis, and provides a meaningful basis for discussing the relative environmental merits of development activities within a particular region. Such an analysis can be used as a medium for meaningful communication with the public and can greatly assist agencies in making sound environmental decisions. Consistent use of such an approach by a variety of federal agencies within a given region can contribute significantly to a regional data base, which can greatly facilitate future EIS preparation and reduce both time and cost.

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APPLICATION OF REMOTE SENSING DATA TO PIPELINE CONSTRUCTION IN ONTARIO

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ABSTRACT

In 1982 and 1983, a total of 680 km of natural gas pipeline was constructed in Ontario. Construction was carried out under a variety of geotechnical, terrain and environmental conditions. Route selection necessitated the detailed mapping of surficial materials, terrain constraints and land use/land cover. Some environmental considerations included the necessity of restoring riverbanks at major river crossings, the monitoring of water quality during construction and the effects of soil compaction on crop yield. This paper describes how various types of remote sensing data were acquired, analyzed and integrated with field data to assess the environmental effects of the pipeline before, during and after construction.

Colour and colour infrared aerial photography was taken, before, during and after pipeline construction, of a number of river crossings in Southern Ontario. Aerial thermography and video recordings were also acquired for selected sites. The digital analysis of LANDSAT data and the visual interpretation of thematic mapper (TM) colour composites provided general land cover data along the pipeline corridors. The interpretation of TM colour composites and SEASAT SAR data provided regional terrain typing at the route-selection stage. Conclusions were drawn as to the type of information that could be derived from each type of imagery.

INTRODUCTION

The design and construction of any environmentally acceptable pipeline requires close attention to geotechnical and environmental considerations and an effective integration of all baseline data into the construction process. For route selection, construction scheduling and post-construction monitoring, large-scale, detailed environmental and geotechnical maps are necessary to show areas of terrain sensitivity and land use priority. The use of remote sensing data as a mapping, sampling and monitoring tool in the overall environmental assessment program for pipeline construction projects is now quite routine. For remote sensing to be effective, however, it is necessary to select the best sensor/scale combination among the variety of data types and formats, and to employ the most appropriate techniques of interpretation. Informed selection can reduce the cost of imagery, data acquisition and interpretation. It is necessary for the choices to be made during the initial stages of the project, particularly when airborne missions are involved, in order to take seasonal variations into account. Ryerson (1981) has documented several studies where costs were lower with the acquisition of new colour and colour infrared photography than with purchase of existing black and white data, when the cost of interpretation was considered. The extent to which remote sensing can contribute to the pipeline construction process as a whole can only be evaluated by assessing individual examples of applications and interpretation techniques. The present paper reports a number of such examples from Ontario, particularly from a joint study performed by the Ontario Centre for Remote Sensing and Union Gas Ltd. since 1982.

PRE-CONSTRUCTION MAPPING AND ROUTE SELECTION

Satellite and airborne images are among the several data types used in route selection. They are used to update existing land cover maps, detect changes in the landscape, plan field sampling programs and locate sensitive environmental and terrain conditions. Whether satellite or airborne images are used depends on the length of the route. In general, black and white airphoto mosaics, satellite imagery and related field studies have been used extensively for pipeline route selection (Mollard 1956, 1959, 1972; Union Gas 1982; Trans Canada Pipelines 1980, 1981). In Southern Ontario, however, where much detailed mapping has been done, route planners have used existing large-scale (1:20,000) panchromatic black and white aerial photographs as a photo basemap for plotting field information.

Regional Mapping with Satellite Data

In Northern Ontario, LANDSAT and SEASAT imagery can be used in conjunction with existing black and white photographs and existing engineering terrain, geological and vegetation maps to select a cross-country pipeline route. Both visual and digital interpretation techniques have their unique contribution to make.

1. Geometrically-corrected 1:250,000-scale LANDSAT Multispectral Scanner (MSS) colour composites or Thematic Mapper data (Figure 10) provide an effective basemap with which field data and information from other maps can be integrated to aid the planning process. TM data, with a resolution of 30 metres, was used in the joint OCRS/Union Gas study to map the orientation and density of fractures and folds in deformed Precambrian rocks. The mapping of the form and orientation of these structures permits the geometric analysis required for an assessment of the stress systems and mechanical properties of the rock foundation on which a high-pressure gas pipeline is to be constructed. The difference between areas of thin and thick till, occurrences of rock outcrop (particularly in recent burn areas) and all access and permanent roads and trails were readily mapped from the TM data, but could not easily be recognized from the standard LANDSAT images. Figure 10 is a September TM scene along the Dryden-Kenora pipeline corridor in Northwestern Ontario.
2. Enhancement techniques similar to those developed for geological exploration programs and rangeland studies can be used for preliminary cross-country pipeline routing studies. A ratio of MSS band 7 and MSS band 5, aided by high bandpass filtering (Singhroy, 1981) and standard reflectance enhancements (Ahern, 1982, 1983), can greatly improve the visual impact and interpretability of standard LANDSAT images, thereby permitting the accurate delineation of lineaments,

lithological boundaries and small-scale engineering terrain units in vegetated areas. Edge enhancement resulting from a low sun-angle sharply accentuates linear patterns. Producing colour composites by principal-component analysis (where channel 1 is red, channel 2 is blue and channel 3 is green) and merging digital SAR and MSS data (Short, 1982) are methods of producing a superior image for small-scale engineering terrain mapping in vegetated areas.

3. The visual interpretation of SEASAT-SAR radar data permits the recognition of areas of terrain roughness, impossibly steep gradients, and shallow soils overlying bedrock and fissured rocks. The mapping of small-scale engineering terrain units is based on the recognition of the spatial variability of textures and patterns. For instance, thin, bouldery till over fractured bedrock presents a speckled, coarse-textured appearance, with a rough and linear pattern: the radar return reflects the ridged and knobby topography and exposed bedrock. More cohesive, fine-grained soils with a higher moisture content appear as homogeneous, darker-toned areas with a finer texture. Figure 11 is an example of engineering terrain interpretation along a portion of the North Bay-Ottawa Trans Canada pipeline corridor.
4. The digital classification of LANDSAT data for land cover mapping can provide an up-to-date record, and can be produced in the form of hard-copy colour thematic maps using a computerized plotter (Pala 1981; Jano 1981). The satellite-based thematic map is especially useful in the north where there is a lack of regional information. A mapping scale of 1:100,000 is recommended. Figure 12 shows a land-cover classification, for the proposed Union Gas Nanticoke Line. In Southern Ontario, where detailed land use maps are available, the LANDSAT approach is more useful for detecting changes in land cover. In general, the computerized, LANDSAT-based method of map production is less expensive than that used to produce the conventional type of corridor land use map at the same scale.

Route Selection with Spring Airborne Imagery

While standard black and white photography is valuable, its usefulness as a geotechnical mapping and sampling tool is limited. As it is intended to serve the needs of forest inventory, it is acquired exclusively during the summer months. Special-purpose mapping for route planning sometimes requires coverage obtained prior to leaf-flush in spring, in order to adequately describe terrain properties and to assess other geotechnical factors which determine the trafficability and workability of the surficial materials. Qualitative information on soil moisture, soil texture, plasticity and compressibility, for example, as well as the approximate location of ground water, can be inferred from spring photography. In poorly-drained agricultural areas, photography obtained before leaf-flush can show the location of subsurface drainage tile networks, which must be located before trenching operations can begin. This coverage also provides information on active geomorphic and hydrologic processes at proposed river crossings during peak discharge - information essential in pipeline design. It is difficult to obtain such specialized information from current black and white photography; the only alternative source of the data is extensive field survey. The following are examples of the application of spring imagery.

(i) Detection of Near-Surface Fractures

During early spring, the lack of vegetation in agricultural areas, the substantial reduction in foliage in forested regions, and the increase in soil moisture make subtle features visible, even though they are not ordinarily seen on standard black and white imagery or included on maps. Figure 1 demonstrates the usefulness of spring colour infrared photography for locating fractures covered by a thin cover of drift along the proposed Nanticoke corridor of Union Gas. Daytime thermography taken at a scale of 1:15,000 has also proven effective in locating these subsurface fractures (Singhroy, 1982). The ability to map these fractures is significant since localized swelling caused by moisture trapped within them may cause a gradual decrease in the shear strength of the surface materials. The presence of moisture in the fracture zones, together with an absence of vegetation cover, permits them to be detected on both the large-scale colour infrared photography and thermal infrared imagery.

(ii) Selection of Geotechnical Sampling Sites

Spring photography enhances soil moisture, thereby allowing inferences to be made regarding soil texture, permeability, compressibility and hydrologically active zones. These relative properties and conditions can be used as a guide to plan a field soil sampling program for geotechnical analysis. It is important, for example, that the location of local glaciolacustrine clay pockets (Jeddo clay loam) within the fluted Halton till in Southern Ontario be mapped prior to pipeline ditching, as these imperfectly-drained clay pockets are potential zones of local ponding. The coefficient of permeability of clay soils in this region varies from 10^{-6} to 10^{-9} cm/sec. This property decreases soil workability, and creates difficulty in trenching and laying pipe under wet conditions. Since clay soils are susceptible to severe compaction and rutting, an early determination of inherent moisture distribution can indicate when the soils can be worked, thus reducing down-time in wet weather. Such down-time is sometimes considerable: Union Gas experienced partial-crew shut-down for a total of twenty days over a three-month period, resulting in a loss of $106,522 over the Kerwood-Strathroy Section and $219,964 over the Bright-Owen Sound Valve Section. Figure 2 shows how spring colour infrared photography can be used to map such local problem areas.

Spring thermography was used together with available geological maps in a preliminary assessment of the permeability of the Port Stanley till of Southern Ontario (Figure 3). In addition, sites showing hydromorphic conditions were located on the spring photographs, as part of a systematic sampling program required for environmental assessment and the rehabilitation of agricultural soils after construction. Areas where the high moisture and low oxygen conditions in spring have increased soil compaction can be located. Such compaction adversely affects yield in most agricultural crops.

(iii) Detection of High Water Table

Pipeline construction is always hindered by excessive soil moisture. The high water table along the recently-constructed Kerwood to Strathroy route of Union Gas has created a number of construction problems. To prevent trench sloughing (Figure 4), areas within the highly-saturated Barrien sands requiring dewatering were identified from spring colour infrared photography (Figure 5). The increase in hydraulic conductivity and buoyancy in these areas of high water table require the use of pipe stabilizers. Infrared photography was valuable in mapping ecologically sensitive wetlands, in assessing their vegetation characteristics, in locating the extent of the water tables, and in solving logistical problems during construction (Figures 6 and 7).

(iv) Detection of Subsurface Drainage Tiles

In the agricultural areas of Southern Ontario, pipeline companies are required, under environmental regulations, to locate drainage tiles and to monitor their effectiveness along rights-of-way before and after construction. Prior to construction, representatives of pipeline companies question property owners about their tiling systems, in an effort to prevent damage to existing systems during the trenching phase. In cases where the proprietor may not know of the existence of tiles because the land has changed hands, spring infrared photography can be used to detect such tiles. A large-scale spring colour infrared photograph (Figure 8) was used in the joint OCRS/Union Gas study to detect systematic tile drainage on the imperfectly-drained Brookston clay near Strathroy. On spring infrared photographs, drainage tiles appear as parallel red lines indicative of the vigorous plant growth associated with well-drained areas (Figure 9). It is advisable that photography for tile detection be obtained between 12 and 36 hours after a rainfall, and during the plowing season (Graham, 1975). Thermal imagery can also be used to locate drainage tiles, but thermal image acquisition and processing costs are considerably higher than those of the colour infrared technique.

CONSTRUCTION AND POST-CONSTRUCTION MONITORING

Large-scale aerial imagery (70mm stereo photography, oblique photography or airborne video recording) is the most practical and economical method of monitoring the pipeline during and after construction. Both regulatory agencies and pipeline companies use such imagery for environmental assessment and for monitoring ground operations and progress. The large-scale (1:10,000-scale or larger) 70mm stereo transparency format is generally used for stereoscopic analysis and measurements of area, distance and height which are sometimes required in engineering studies and litigation processes. During construction, airborne data is acquired to monitor clearing of the area, construction of the work pad, removal and preservation of topsoil, trenching and backfill, dispersion of suspended sediment at river crossings, and subsequent clean-up activities. Since the main purpose of this data is simply to provide a permanent visual record for environmental monitoring and the planning of construction logistics, and to supplement the simultaneous collection of water quality data at river crossings, stereo coverage is usually not necessary. Aerial oblique photography and video recordings obtained from light aircraft have produced good results on the Kerwood-Strathroy line of Union Gas in Southern Ontario.

River Crossings and Bank Stability

The stability of valley slopes and streambed material is the most important factor in the design of a buried pipeline river crossing. While field investigation is required to determine scour, the properties of bottom sediments, river depth and velocity, and the gradient of the stream bed, airborne imagery can supply valuable data for monitoring the behaviour of the river during peak spring discharges. Large-scale normal colour photography obtained in spring can be particularly useful in measuring river width at the bankfull stage; in calculating the steepness of upper valley slopes; in locating ice, log jams and boulder rapids; in providing a visual record of the dispersion of suspended load, aggrading and downcutting processes and transitory channel deposits; and in permitting the delineation of flood plain zones. The identification of types of slope failure is particularly important in planning post-construction bank stability measures and the re-vegetation of slopes. Large-scale colour infrared and normal colour photography were used in the joint OCRS/Union Gas study to map bare soil exposures at the Sydenham, Nith and Thames river crossings. Local mottled patterns are indicative in incipient forms of sheetwash, parallel and subparallel rills, and gullied channels. Sometimes sharp breaks in slope continuity, along with areas of spring sapping, can indicate potential slide zones. Erosion along the right-of-way is usually evidenced by mudflows, slumping and surface runoff in cut rills and small channels.

During construction, localized water quality degradation can result from in-stream construction activities. The increase in suspended sediment is an important water quality concern. Martz (1980) noted a 36% increase in suspended sediment resulting from construction activities in a minor stream. Table II and Figure 14 demonstrate that there has been a rapid increase in suspended solids in some rivers in Ontario. A high concentration of suspended sediments impairs the respiration of fish and other aquatic organisms with gills. In addition, the fact that turbid water blocks out sunlight can result in reduced photosynthesis in aquatic plants and algae. Moncrieff (1981) noted significant damage to benthic communities downstream of the Thames River pipeline crossing of Union Gas. MacLaren Plansearch Inc. (1983) reported that aquatic micro-vertibrate populations at a location 250 m downstream were severely affected. At the Nith River crossing, however, it was found that the impact lessened with distance downstream (Table III). Normal colour and colour infrared stereo photographs (70mm format), showing the degree of disturbance and the extent of downstream dispersion of sediments, have been used to support field sampling programs at several river crossings in Ontario. Figures 15, 16 and 17 show colour infrared photographs taken before, during and after construction.

Unprotected riverbanks are potentially unstable areas because of continuous downslope erosion and periodic basal erosion. The gradual softening of the soil mass and the resultant decrease in in-situ mass strength of the soil can sometimes result in slides on the unprotected riverbank. When pipe installation and grading have been completed at river crossings, environmental regulations require that riverbanks be restored to their original contours. The restoration process involves the replacing of excavated soils with fill, followed by seeding with a legume-grass mix, then mulching. Figure 17 illustrates the use of spring colour infrared photography to monitor the first stages of growth of new vegetation on the banks of the Nith River. Figures 18 and 19 are normal colour stereo photos of the results of stabilizing measures and mulching soon after construction at the Thames and Credit Rivers.

Crop Damage Assessment

One of the important factors contributing to a reduction in crop yield along a pipeline right-of-way is a significant change in the physical and chemical properties of the soil (Quigley 1979; Shields 1980; DeJong 1973). Soil compaction caused by the vibration of heavy equipment during construction is the main cause. Soils along rights-of-way in Southern Ontario are quite dense, having low infiltration and a low moisture content (Table IV). The compacted soil inhibits penetration by roots and water. Field observations indicate that an iron pan has formed below the A horizon, as a result of fluctuations in water level which deposit dissolved iron over the compacted material (Van den Broek, 1982).

Union Gas Ltd. carried out rehabilitation of the agricultural lands along the Dawn-Kerwood pipeline loop in Southern Ontario. First, the company collected and evaluated data on soils, crops and management practices. The field survey showed that yield had dropped significantly in a variety of crops along the right-of-way (Figures 20 and 21). A lack of surface drainage, compaction of the soil, decreases in organic matter and different practices of farm management are some of the causes for reduced crop yield.

Airborne colour infrared photographs (70mm-format vertical and oblique) were used to monitor the effects of construction on crop yield. The following is a summary of the monitoring process:

1. During construction, colour infrared photography was taken to provide a permanent record of topsoil conservation and to assess the vigour of the crop along the right-of-way.
2. During the spring months following construction, colour infrared photography was taken to locate drainage tiles and to identify those which had been clogged or ruptured during construction. In addition, local ponding due to soil compaction and ruts caused by vibration from heavy vehicles were identified. As moisture-deficient areas appear as light-toned linear patterns on the colour infrared photographs (Figure 22), a variety of moisture-related patterns could be interpreted.
3. Photography taken during the growing and maturing periods was used to monitor crop development and to identify problems contributing to reduced yields. Such problems included soil erosion, moisture stress, weed infestation, crop disease and insects. The uniformity of crop ripening and variations in yield were also identified from sequential colour infrared photography.

Poor growth was observed on all crops growing along the right-of-way (Figures 22 and 23). Extreme cases of poor growth in mixed grain and corn were observed on severely-compacted, clayey soils. The same crops grew better on well-drained, sandy soils where compaction was less severe. The results of performing sub-soiling as a rehabilitation measure are encouraging, however. Figure 24 is a colour infrared photograph showing the improved performance of tobacco after subsoiling. Under these circumstances, the infrared photography is used to monitor the rate of improvement after rehabilitation.

The successful use of colour infrared photography for the detection of crop stress within a field has been documented (Basu _et_ _al._ 1977; Basu 1981; Kain 1977; Wallen _et_ _al._ 1977; Thomas and Gerbermann 1977). Poor crop performance along the right-of-way is interpreted from an analysis of film densities. As part of the OCRS/Union Gas study, density values were recorded from a single roll of colour infrared film using a Macbeth TR 527 densitometer. A comparison of optical readings of density with field estimates of corn and soyabean yields (Figures 20 and 21) showed that increases in density corresponded to increases in crop yield encountered off the right-of-way. Likewise, decreases in optical density corresponded to decreases in crop yield encountered on the right-of-way. However, this correlation may not be reliable, as field conditions and phenological characteristics of the crops which influence film density do not necessarily affect yield. During the post-construction phase, colour infrared photography can only be used as a monitoring tool, to provide indicators of crop stress, and to assess the rate of crop improvement after rehabilitation of agricultural soils.

CONCLUSIONS AND RECOMMENDATIONS

Remote sensing cannot be used independent of other sources of information in pipeline studies. Its value is governed to a large extent by the correct selection of data type, the timing of data acquisition and the interpretation techniques used. However, the remote sensing approach offers flexibility in data integration, and can be tailored to the budget restrictions of the individual job.

At present, pipeline companies and regulatory agencies make only limited use of remote sensing data and techniques, in part because there is relatively little documentation of remote sensing procedures and results in geotechnical engineering and environmental impact studies. Furthermore, as pipeline companies must already comply with the data-gathering required by environmental regulations, they tend to resist undertaking additional data acquisition, even though it may be in their best interests in the long run. In addition, while remote sensing has proven to be an effective mapping and monitoring tool, it is generally believed to be an expensive technique. In fact, the benefits derived from a common-sense integrated approach, using appropriate sensors and interpretation techniques, far outweigh the cost. When the cost and efficiency of the current practice of weekly helicopter flights along the pipeline are compared with the cost and efficiency of a combination of digital LANDSAT-based land cover maps, 70mm colour infrared photography, video recording techniques and selective use of the available SEASAT-SAR data and enhanced LANDSAT data, it becomes evident that remote sensing techniques merit careful testing. Table V provides a list of recommended remote sensing data types useful in each phase of the construction process.

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DESCRIPTION OF FIGURES

FIGURE 1	Early Spring colour infrared photograph showing moisture-enhanced linears and sinks 'A' which are related to subsurface fractures. Location - Caledonia, Southern Ontario, along the proposed Nanticoke gas pipeline route.
FIGURE 2	Late Spring colour infrared photograph showing poorly drained alluvial pockets and lacustrine clay 'B' along the Niagara gas pipeline route.
FIGURE 3	Mid-Spring thermography showing well-drained glaciofluvial outwash sand indicated by light tone (warmer) at 'C' and the wet (cooler) silt till (Port Stanley Till) indicated by dense micro-drainage networks at 'D'.
FIGURE 4	High water table and associate trench sloughing encountered during construction.
FIGURE 5	The darker tone 'F' on the colour infrared photograph corresponds to the saturated Barriend sand on Figure 4.
FIGURE 6	Colour infrared photograph showing the boundary of sensitive bog terrain and high water table zone.
FIGURE 7	Construction activity within bog area shown on Figure 6.
FIGURE 8	Mid-Spring colour infrared photograph showing systematic tile drainage on the heavy Brookston clay along Union Gas pipeline route.
FIGURE 9	Late Spring colour infrared photograph showing old tile drainage system.
FIGURE 10	LANDSAT 4 thematic mapper colour composite (1-2-3) (resolution 30 m) showing terrain segment along pipeline route near Dryden, Ontario.
FIGURE 12	Regional land cover map produced from digital LANDSAT techniques along Union Gas proposed Nanticoke gas pipeline corridor.
FIGURE 15	CIR photograph showing the condition of the site before construction at the Nith River crossing.
FIGURE 16	CIR photograph showing suspended sediment dispersion 'G', downstream during construction from crossing at the Nith River.
FIGURE 17	Post construction monitoring of revegetation emergence 'H' on banks of Nith River using small format (70 mm) CIR photograph.
FIGURE 18	Monitoring of clean-up activities and river bank stability measures along Oakville Creek crossing, using 70 mm normal colour aerial photography.
FIGURE 19	Monitoring clean-up activities and river bank stability measures along the Thames River crossing using 70 mm normal colour photography.
FIGURE 22	70 mm CIR photograph showing the effects of pipeline construction on corn crop growth.
FIGURE 23	70 mm CIR photograph showing the effects of pipeline construction on winter wheat and pasture growth.
FIGURE 24	The use of 70 mm CIR photograph to monitor the improved growth of tobacco after subsoiling at 'H' along the right-of-way.

TABLE II
SUSPENDED SOLIDS CONCENTRATIONS RECORDED DURING INSTREAM CONSTRUCTION IN WATER COURSES IN ONTARIO (mg/L)

		Situation			
Watercourse	Year	Background or Control	Trenching	Backfilling	Post-Construction
Credit River[1]	1981	15-23	526-622	247-775	28-46
Upper Thames River[2]	1981	27-28	2730	1734	8-10
Sydenham River[2]	1982	50-80	1500-2073	1300	150
Galt Creek[3]	1978	5-10	2500-6000	-	75
Fletcher Creek, Mich.[4]	-	5-11	2482-4242	-	17-47
Bronte Creek[1]	1981	5-8	158-160	-	14-43
Nith River	1982	50	325	98	10

Sources:
1. MacLaren Plansearch Inc. 1982
2. Union Gas Ltd.
3. Mathers 1978
4. Crabtree _et al._ 1978

TABLE III
DRIFT NET CATCH SUMMARY OF AQUATIC MICRO-VERTEBRATE POPULATIONS AT NITH RIVER CROSSING

Taxonomic Grouping		Situation					
		Pre Construction		During Construction		One week Post Construction	
		U/S	D/S	U/S	D/S	U/S	D/S
Ephemeroptera	Species	1	1	1	4	2	3
	Individual	11	13	66	15	33	51
Trichoptera	Species	2	1	3	1	2	2
	Individual	11	3	12	1	1	28
Coleoptera	Species	2	1	2	3	-	2
	Individual	2	1	2	3	-	2
Diptera	Species	3	6	4	2	3	2
	Individual	230	406	201	93	44	37
Total organisms	Species	14	11	13	14	10	11
	Individual	288	430	280	112	78	118

NOTE: Number of individuals reduced to catch over a common 24-hour period.
U/S - upstream of construction
D/S - downstream of construction

Source: MacLaren Plansearch Inc. 1983

TABLE IV
SOIL MOISTURE CONTENT (% BY WEIGHT) ALONG DAWN-KERWOOD LOOP PIPELINE

A. 0-20 cm depth

Farm	Control	Right-of-Way 42	Right-of-Way mid 42	Right-of-Way 36
1.	35.83	29.03	34.80	27.68
2.	28.21	24.48	27.10	24.86
3.	18.61	18.51	26.68	22.78
4.	30.48	23.60	24.34	21.96

B. 20-40 cm depth

Farm	Control	Right-of-Way 42	Right-of-Way mid 42	Right-of-Way 36
1.	-	-	-	-
2.	26.67	21.78	26.22	26.32
3.	19.14	21.25	16.66	17.88
4.	29.48	23.61	22.70	23.57

Source: Ecological Services for Planning Ltd. *ec al.* 1983

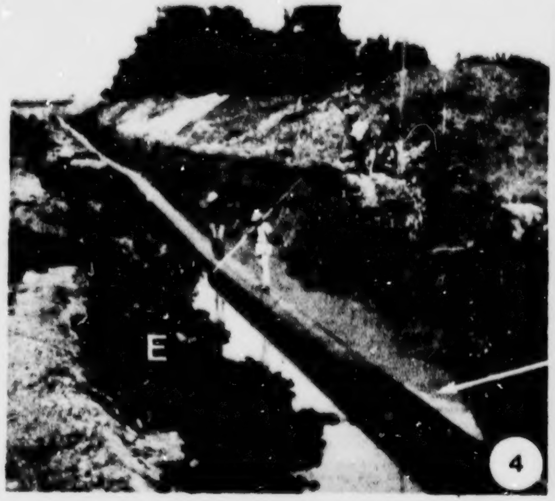
TABLE V SOME RECOMMENDED REMOTE SENSING DATA AND TECHNIQUES FOR SELECTED GEOTECHNICAL AND ENVIRONMENTAL APPLICATIONS RELATED TO PIPELINE CONSTRUCTION IN ONTARIO

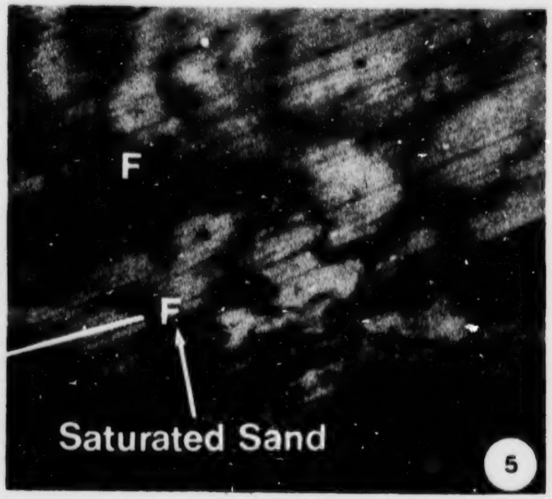
			ROUTE PLANNING AND PRE-CONSTRUCTION PHASE		CONSTRUCTION PHASE		POST CONSTRUCTION AND ENVIRONMENTAL MONITORING		
REMOTE SENSING DATA	TIME OF DATA ACQUISITION	INTERPRETIVE TECHNIQUES	APPLICATION	LOCATION	APPLICATION	LOCATION	APPLICATION	TIME	LOCATION
SENSOR - PANCHROMATIC BLACK & WHITE SCALE - 1:10,000-1:20,000 FORMAT - 9"x9" CONTACT PRINTS AVAILABLE FOR ALL OF ONTARIO.	SUMMER	MANUAL INTERPRETATION FROM SINGLE PHOTOS OR STEREO PAIRS.	GENERAL LAND USE/LAND COVER MAPPING (LEVEL III & IV CLASSIFICATION). PROPERTY BOUNDARY AND RELATED CULTURAL LANDSCAPES AND ACTIVITIES. GENERAL ENGINEERING TERRAIN INFORMATION. RIVER CHANNEL TYPE AND MORPHOLOGY AT CROSSINGS.	ENTIRE ROUTE					
SENSOR - NORMAL COLOUR SCALE - 1:10,000-1:20,000 FORMAT - 9"x9" CONTACT PRINTS OR 9"x9" ENLARGEMENTS FROM 70MM NEGATIVES.	EARLY SPRING DURING AND IMMEDIATELY AFTER SNOW MELT.	MANUAL INTERPRETATION FROM SINGLE PHOTOS OR STEREO PAIRS.	MEASUREMENT OF BANK FULL DISCHARGE AND OVERBANK FLOODING IN THE VICINITY OF MAJOR CROSSINGS. IDENTIFICATION OF ICE AND LOG JAM ZONES, AND ASSOCIATED EROSION FROM RIVER ICE AND SPRING RUN-OFF. (SPECIAL FLIGHTS MAY BE REQUIRED DURING SPRING BREAK-UP ALONG THE RIVER IN THE VICINITY OF CROSSINGS.) VISUAL EVIDENCE OF PRIMARY AND SECONDARY CURRENTS, SUSPENDED LOAD AND EROSIVE PROCESSES. MAPPING OF TRANSITORY CHANNEL DEPOSITS, LAY AND CHANNEL FILLS, ZONES OF CHANNEL SHIFTING, BACK SWAMP DEPOSITS AND TEMPORARY BOULDER RAPIDS. FABRICATION OF ZONES OF MASS WASTING, SLOPE INSTABILITY AND TOE EROSION.	MAJOR RIVER CROSSINGS	ASSESSMENT OF FOREST CLEARING, SOIL STRIPPING AND DITCHING ACTIVITIES.	ENTIRE ROUTE	ASSESSMENT AND MONITORING BANK STABILITY MEASURES AND PROCESSES AT CROSSINGS.	SUMMER	CROSSINGS.
					MEASUREMENT OF AREAS AND IDENTIFYING DISPERSION PATTERNS OF SUSPENDED SEDIMENTS, OIL AND GREASE, DOWNSTREAM FLOW DREDGING OPERATIONS AT RIVER CROSSINGS.	RIVER CROSSINGS	ASSESSMENT OF GULLY EROSION, SETTLEMENT AND PONDING ON RIGHT-OF-WAY.	SPRING	ENTIRE ROUTE
SENSOR - COLOUR INFRARED SCALE - 1:10,000-1:20,000 FORMAT - 9"x9" CONTACT PRINTS OR 9"x9" ENLARGEMENTS FROM 70MM NEGATIVES.	EARLY SPRING	MANUAL INTERPRETATION FROM SINGLE PHOTOS OR STEREO PAIRS.	MAPPING OF CLAY POCKETS AND DEWATERING ZONES , HIGH AND LOW GROUND WATER LEVEL, SURFACE PONDING AND BOULDERY TILLS, AND GENERAL WORKABILITY OF SOILS. LOCATION OF TEMPORARY AND PERMANENT STREAMS. MAPPING THE DISTRIBUTION OF SOIL MOISTURE FOR ASSESSMENT OF REHABILITATION MEASURES AFTER CONSTRUCTION. LOCATION OF DRAINAGE TILE SYSTEMS. MAPPING OF DETAIL GEOTECHNICAL UNITS (MATERIALS, TERRAIN-SLOPE & MOISTURE). DELINEATING FRACTURE AND JOINTING PATTERNS.	ENTIRE ROUTE	LOCATION OF DEWATERING ZONES IN PIPELINE TRENCH AND AREAS OF HIGH WATER TABLE.	ENTIRE ROUTE	EVALUATION OF MOISTURE CONDITIONS IN RELATION TO SOIL TYPES IN AREAS ON AND ADJACENT TO RIGHT-OF-WAY.	SPRING	AGRICULTURAL AREAS
							ASSESSMENT OF CROP DEVELOPMENT AND CROP TYPE ALONG RIGHT-OF-WAY.	MID-JUNE	
							ASSESSMENT OF CROP VIGOUR IN RELATION TO REHABILITATION PROCEDURES.	LATE JULY EARLY AUGUST	
							ASSESSMENT OF REVEGETATION CONDITIONS ON RIVER BANKS.		RIVER CROSSINGS
							ASSESSMENT OF RESTORATION PROCEDURES ON AGRICULTURAL LAND.	SUMMER	AGRICULTURAL AREAS
SENSOR - THERMAL INFRARED SCALE - 1 10,000-1:20,000	WINTER	MANUAL INTERPRETATION OF POSITIVE TRANSPARENCIES AND SELECTIVE DENSITY LEVEL SLICING.					ASSESS THE EFFECTS OF HEAT CREATED BY HIGH PRESSURE GAS LINE ON PHYSICAL PROPERTIES OF SOIL. POSSIBLE DETECTION OF AREAS RELATED TO GAS LEAKS.	WINTER (NIGHT)	AGRICULTURAL AREAS
SENSOR - VIDEO, NORMAL COLOUR SCALE - FORMAT - VIDEO TAPE AND AERIAL OBLIQUES 35MM AND 70MM.	SPRING	MANUAL INTERPRETATION FROM VIDEO MONITOR. IT IS DIFFICULT TO PERFORM ACCURATE MEASUREMENTS FROM VIDEO SCENES AND AERIAL OBLIQUES. VISUAL RECORD OF LANDSCAPE IS THE ONLY ADVANTAGE. THIS TECHNIQUE MAY NOT BE APPROPRIATE IF OTHER AIRBORNE DATA ARE TAKEN SIMULTANEOUSLY.	DETERMINATION OF THE NATURE OF LAND COVER ALONG SELECTED PORTIONS OF THE RIGHT-OF-WAY. VISUAL ASSESSMENT OF RIVER PROCESS AT CROSSINGS.		TO DETERMINE THE PROGRESS OF CONSTRUCTION OPERATIONS ON RIGHT-OF-WAY. SOME VISUAL DETERMINATION OF SUSPENDED SEDIMENT DISPERSION DOWNSTREAM FROM RIVER CROSSING.		SEQUENTIAL FLIGHTS TO MONITOR CROP GROWTH AND DENSITY ALONG RIGHT-OF-WAY.	SPRING SUMMER FALL	AGRICULTURAL AREAS
SENSOR - LANDSAT, COLOUR COMPOSITE SCALE - 1:1,000,000 OR 1:250,000	MULTI-TEMPORAL COMPARISONS AS REQUIRED.	MANUAL INTERPRETATION. IMAGE ENHANCEMENT USING 1ST AND 2ND PRINCIPAL COMPONENTS IS EFFECTIVE IN POINTING OUT SUBTLE VARIATIONS IN SOIL ROCK MATERIALS AND ENHANCING FRACTURE PATTERNS.	REGIONAL MAPPING OF LINEAMENTS, MAJOR VEGETATION TYPES AND STRATIGRAPHIC UNITS. IDENTIFICATION OF MUSKEG AREAS.						
FORMAT - LANDSAT CCT DICS PRODUCT	SPRING								
- LANDSAT CCT	SUMMER	CLASSIFICATION	LANDSAT LAND COVER CLASSIFICATION LEVEL I AND II, PARTICULARLY USEFUL IN NORTHERN ONTARIO.						

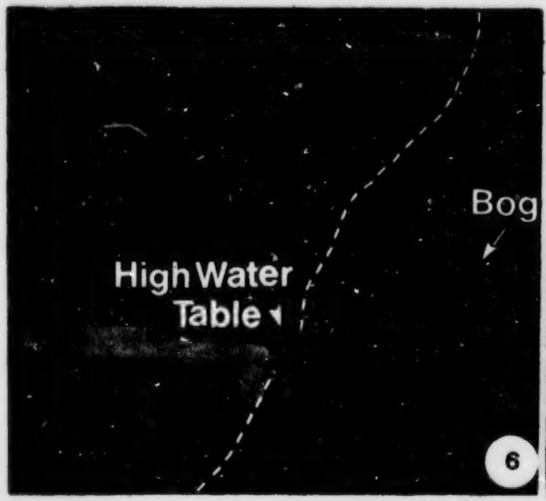
A
1

DCRS
2

C
D
3

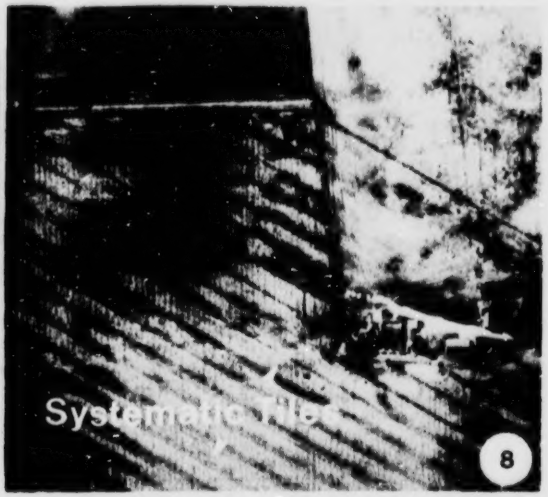

E
4


F
F
Saturated Sand
5


High Water
Table
Bog

⑥

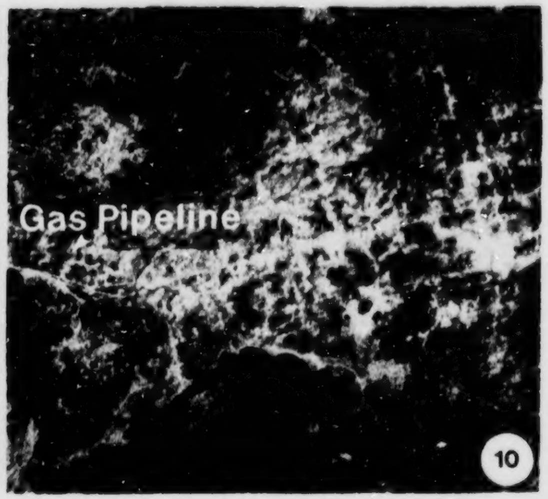
⑦


Systematic Tiles

⑧

Old Tile
System

⑨


Gas Pipeline

⑩

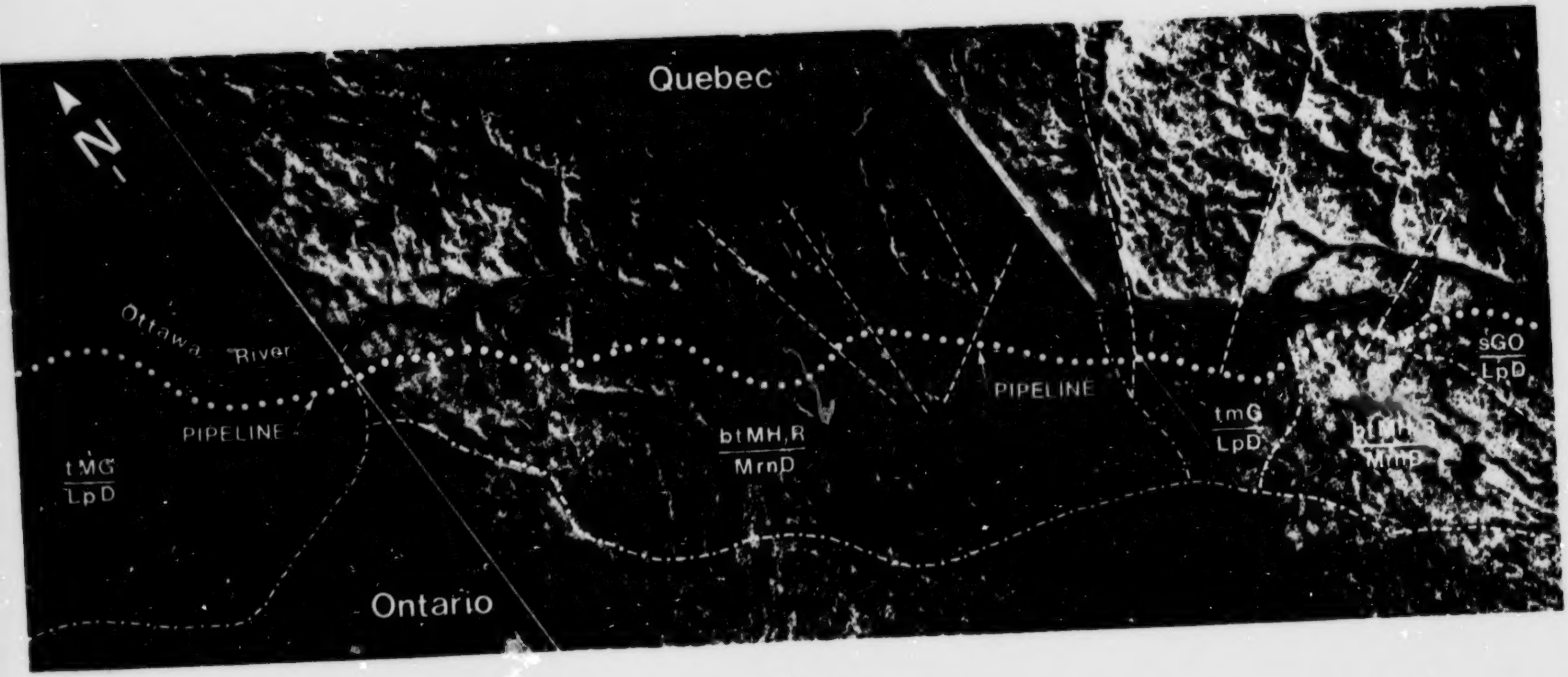

N
Quebec
Ontario
Ottawa River
PIPELINE
PIPELINE
tMG
LpD
btMH,R
MrnD
tmG
LpD
btMH,R
Mrnp
sGO
LpD

Figure 11

Regional engineering terrain mapping from SEASAT-SAR image of a portion of the North Bay-Ottawa corridor. (scale: 1:260,000)

LEGEND

EXAMPLE

material → tMG ← dominant landform
local relief → LpD ← drainage, topographic variety

SYMBOLS

– – – – –	lineament
—·—·—	approximate engineering terrain boundary

MATERIAL

b	boulders, bouldery
s	sand, sandy
t	till

LANDFORM

MG	Ground moraine
MH	Hummocky moraine
GO	Outwash plain

LOCAL RELIEF

L	Mainly low local relief
M	Mainly moderate local relief

VARIETY

p	plain
r	ridged
n	knobby

DRAINAGE

D	Dry

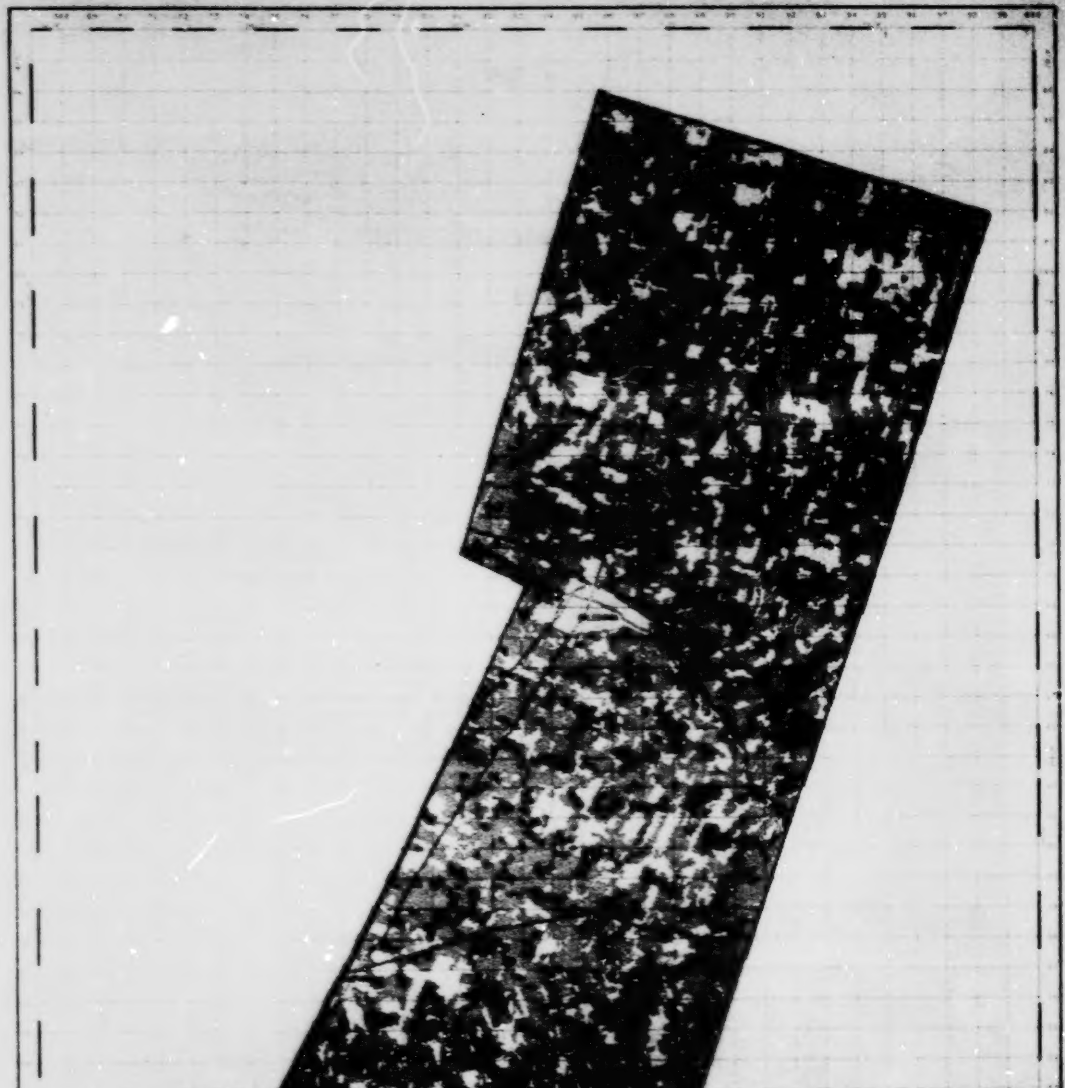
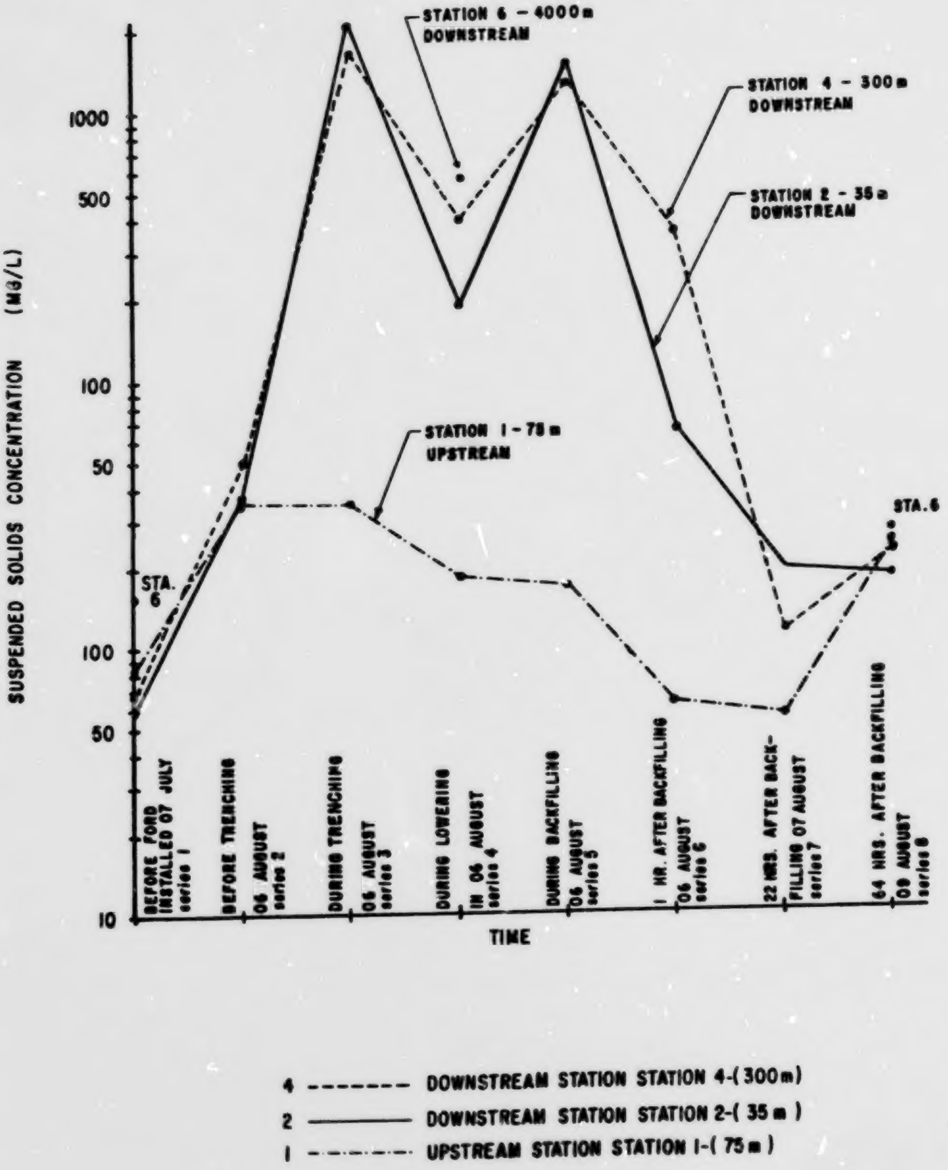

LAKE ERIE
PROPOSED NANTICOKE GAS PIPELINE

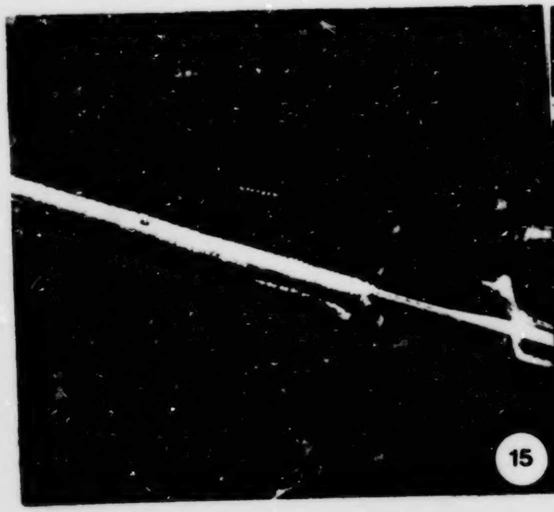
Figure 12

Figure 14

Suspended Solids Concentration In The Sydenham River: Relative to Instream Construction Activites



SOURCE: ECOPLANS LM 1983



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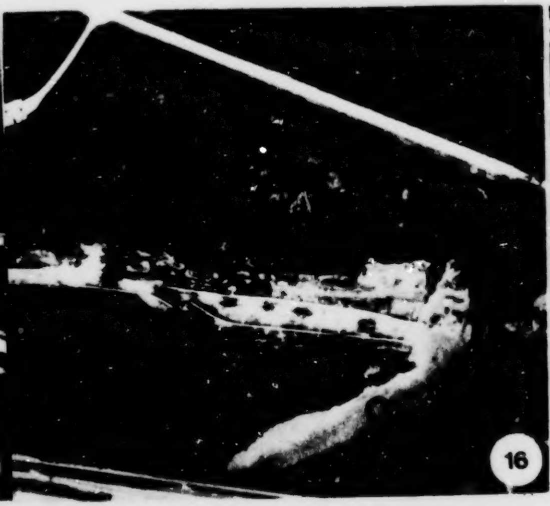

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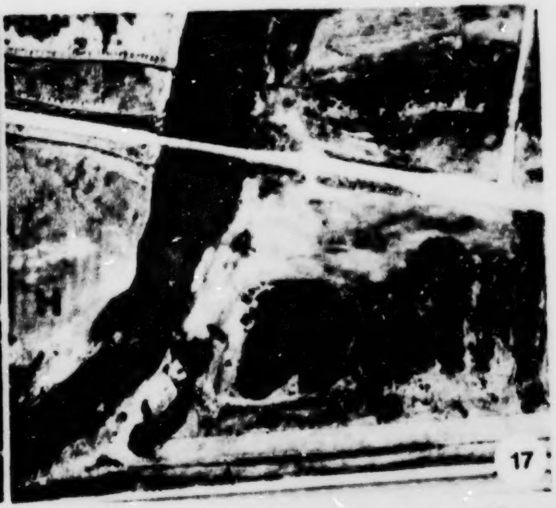


17

Nith River before construction ----------During construction ------------After construction

River
Bank
stability
measures

18

19

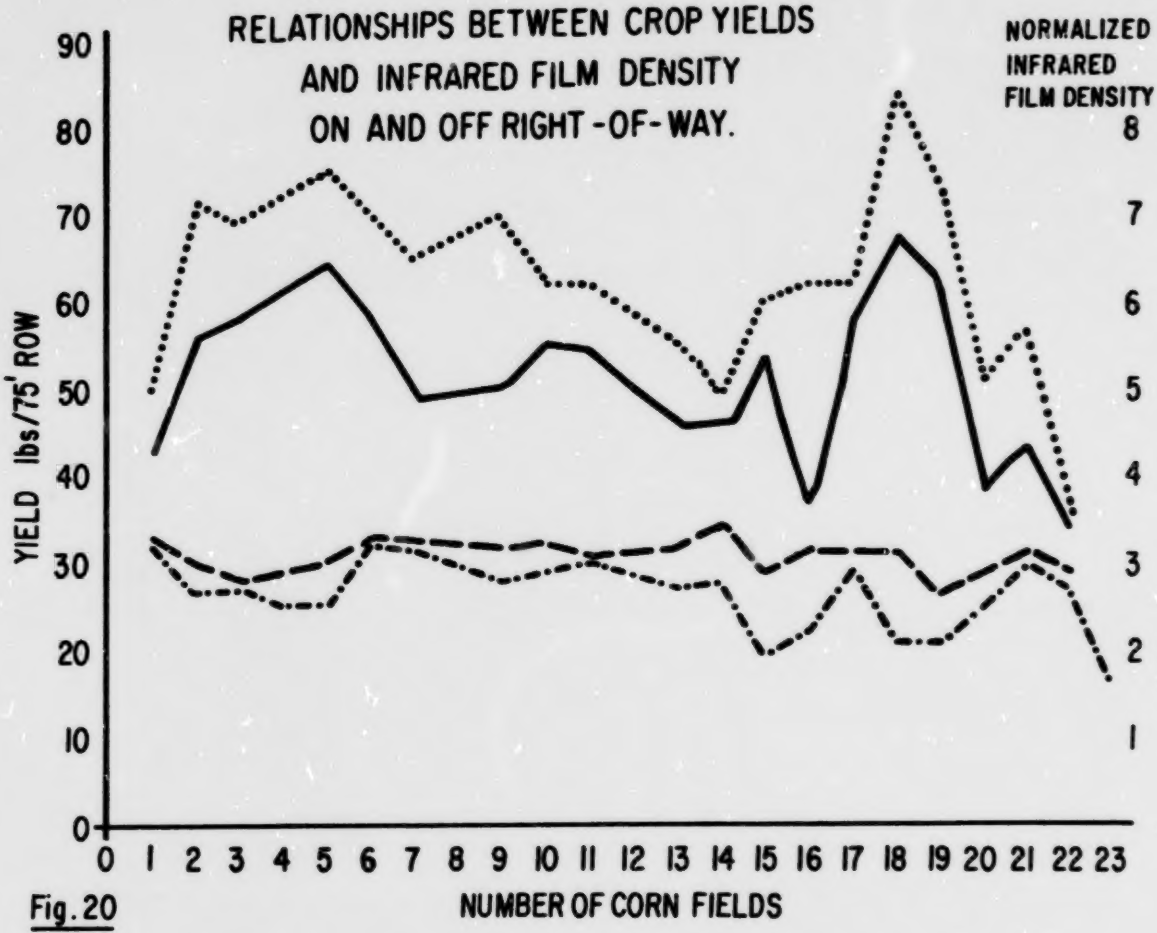
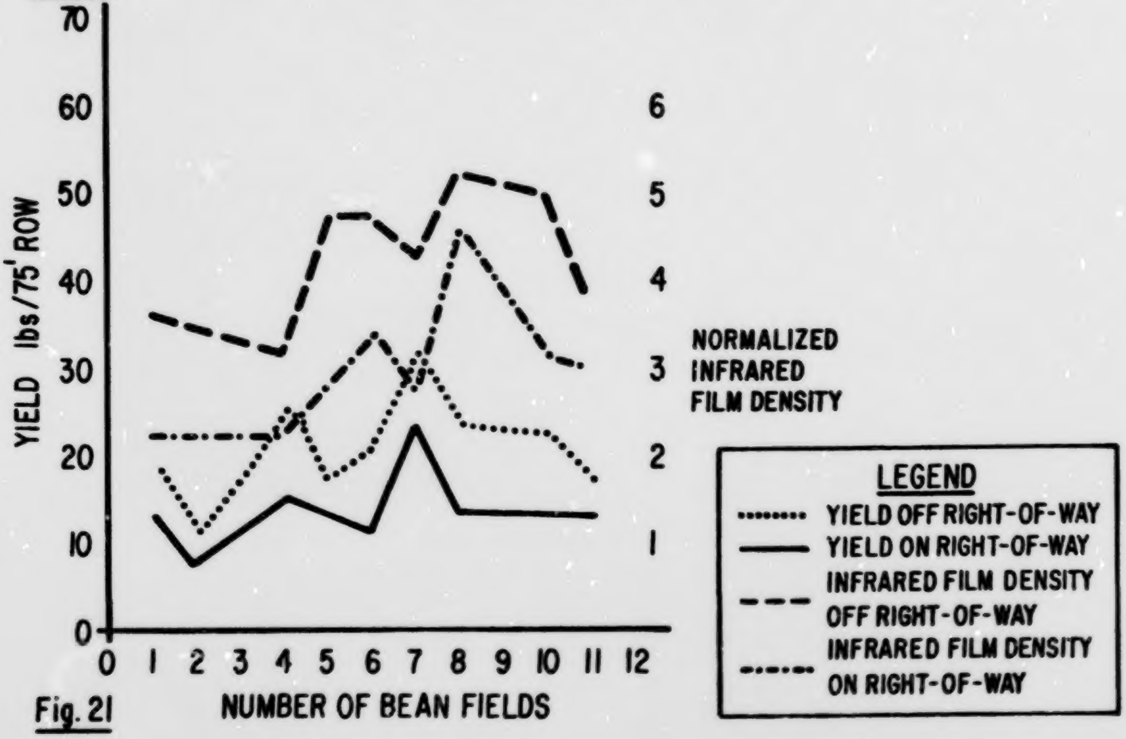

RELATIONSHIPS BETWEEN CROP YIELDS
AND INFRARED FILM DENSITY
ON AND OFF RIGHT-OF-WAY.
NORMALIZED
INFRARED
FILM DENSITY
YIELD lbs/75' ROW
0
10
20
30
40
50
60
70
80
90
1
2
3
4
5
6
7
8
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
NUMBER OF CORN FIELDS

Fig. 20


YIELD lbs/75' ROW
0
10
20
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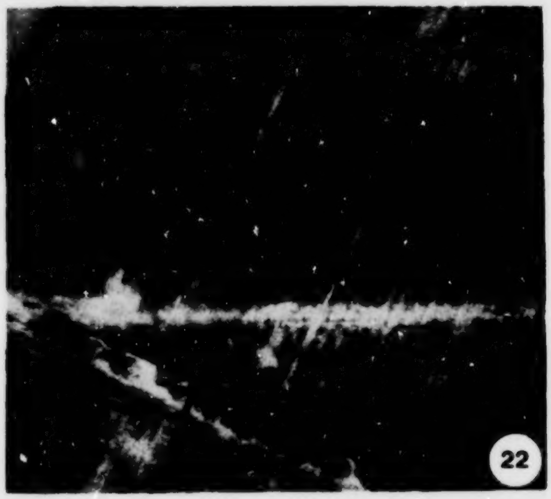
50
60
70
1
2
3
4
5
6
NORMALIZED
INFRARED
FILM DENSITY
0 1 2 3 4 5 6 7 8 9 10 11 12
NUMBER OF BEAN FIELDS
LEGEND
YIELD OFF RIGHT-OF-WAY
YIELD ON RIGHT-OF-WAY
INFRARED FILM DENSITY
OFF RIGHT-OF-WAY
INFRARED FILM DENSITY
ON RIGHT-OF-WAY

Fig. 21



22

Poor crop growth on right of way

23

24

Abstract

Ecological Criteria for Siting of Geothermal Projects

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Oak Ridge, Tennessee 37831 *
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The ecological impacts of geothermal development can be minimized or avoided by incorporating available ecological information and well-designed ecological surveys early in the site-selection process. In this study, we examined environmental assessment documents for each of 30 proposed or operational projects to identify the major potential ecological impacts for projects intended to exploit three major resource types: hydrothermal, hot dry rock, and geopressured resources. We then used these results to formulate guidance for collecting pertinent ecological data and to develop ecological criteria suitable for use in future siting of geothermal projects.

We found that, although some impacts would be common to all three resource types, several potentially important ecological impacts differed significantly among the three categories, e.g., potential effects of uncontrolled fluid releases into aquatic and wetland resources overlying the geopressured resource of the Gulf coastal zone could be considerably greater than hydrothermal releases into ephemeral streams in the West. The ecological criteria developed in this study are presented in an environmental site-selection checklist. Among the site-selection criteria developed in this study, by resource type, are 1) avoidance of undisturbed wetlands in the geopressured zone by siting new projects on either chenier ridges or previous drilling sites; 2) avoidance of areas near streams supporting fisheries of high quality (hydrothermal projects); and 3) avoidance of major migratory routes for elk and other important mammals (hot dry rock).

*Based on work performed at Oak Ridge National Laboratory, operated for the U. S. Department of Energy under contract W-7405-eng-26 with Union Carbide Corporation.

POSTER HIGHLIGHTS

Ecological Criteria for Siting of Geothermal Projects

Our retrospective evaluation of environmental documents for approximately 30 geothermal projects revealed a need for the development of siting and mitigation criteria for protection of ecological resources. Projects representing three major types of geothermal resources were examined (Figs. 1 and 2):

- Hydrothermal -- reservoirs dominated by hot, pressurized water and/or stream. Most of the world's geothermal projects exploit this type of resource. In the United States, most development has taken place in the west.
- Hot dry rock -- anomalous hot areas of rock near the earth's surface resulting from magma penetrating unusually high into the earth's crust. Exploitation of this resource requires pumping of fluid into the hot dry rock and back to the surface for heat exchange. Again, the western U.S. offers the most promise for development.
- Geopressured -- very deep reservoirs (often several kilometers deep) of highly pressurized, hot water (often brines) requiring very expensive drilling for development. The largest and most promising geopressured reservoirs lie beneath the Gulf coast of Texas and Louisiana.

These geothermal resources occur in regions of widely different climatological and ecological characteristics (Figs. 3-6). Many of the hydrothermal and hot dry rock known geothermal resource areas (KGRAs) lie in arid-to-semiarid regions of the western U.S. (Fig. 3) inhabited by terrestrial plants and animals adapted to these conditions. Aquatic ecosystems range from ephemeral streams (washes and arroyos) and lakes (playas) to high quality trout streams in areas receiving moderate amounts of rain such as the Geysers KGRA in California. Geopressured resources, on the other hand, often lie beneath exceedingly productive and complex wetland and estuarine ecosystems along the Gulf Coast.

Potential Impacts

The potential ecological impacts of geothermal development will naturally vary on a project-specific basis according to 1) characteristics of the resource itself (e.g. chemistry of the geothermal fluid); 2) the particular methods to be used for exploitation of the resource (e.g. electricity production versus direct heating) and the size of the project; 3) the geological, meteorological, chemical, and biological features of the local environment; and 4) the specific mitigative measures to be used. Further, ecological impacts of development can follow from hazards related to routine exploration, construction, and operation activities, and from accidents (blowouts, other uncontrolled releases of effluents, and subsidence). Major sources of ecological impacts include:

- Atmospheric emissions (Figs. 7 and 8) -- Fugitive dusts raised during construction of roads, well-pads, and other facilities, and emissions from steam venting and cooling towers can harm plants, animals, and soil systems through deposition, toxicity, and alteration of the chemical environment. Potentially important pollutants include H_2S, NH_3, HF, SO_2, B, As, and Hg. Steam and CO_2 may alter local climatology.
- Noise -- Certain operations such as venting and air drilling can produce noise rivalling that of a jet engine (e.g. >100 dB). Noise of this intensity can seriously disturb sensitive wildlife in the area.
- Construction-related activities -- Activities such as road (Fig. 9), well-pad, pipeline, and canal construction directly destroy biota in the immediate area of these activities, and may indirectly disturb surrounding habitat through alterations in circulation patterns (e.g. estuarine systems of the Gulf Coast), blockage of animal movement, and increased suspended solids. Such activities may also result in landslides and soil erosion devastating to both terrestrial and aquatic ecosystems.
- Planned or accidental liquid discharges (chemical or thermal pollution; Figs. 10 and 11) -- Both terrestrial and aquatic ecosystems could be damaged or destroyed by the planned or accidental (blowouts, spills) release of hot geothermal fluids, drilling muds, and lubricants. Geothermal fluids, in particular, besides being very hot, may contain unusually high concentrations of total dissolved solids (as much as eight times that of saltwater), NH_3, H_2S, and trace elements (I, Br, B, F, Pb, Zn, Fe, Mg, Ni, As, Al, Cu, Mn, and Ra-226). Other geothermal fluids, on the other hand, may rival or exceed local surface waters in water quality, and consequently may be profitably used after suitable cooling to enhance area ecosystems, or in agriculture or aquaculture.
- Subsidence -- Withdrawal of geothermal fluids may result in a general sinking (subsidence) of the land overlying the resource. Subsidence is believed most likely to occur in areas overlying liquid-dominated hydrothermal reservoirs (e.g. the Imperial Valley in southern California). Potential impacts of subsidence include disruption of irrigation systems (particularly in the west), alteration of flow regimes in coastal wetlands, streams, and estuaries, and flooding of terrestrial ecosystems and farmland.
- Consumption of surface waters and/or groundwaters contributing to aquatic ecosystems (e.g. via springs) for cooling and other purposes. Water consumption can severely stress certain aquatic ecosystems in the western U.S.

Tables 1, 2, and 3 list predicted impacts for specific geothermal projects.

Mitigation

Mitigation or avoidance of ecological impacts entails three major steps: 1) a pre-site selection survey of ecological resources,

2) implementation of a program of specific measures for impact mitigation and avoidance, and 3) monitoring of ecological resources for evidence of impacts.

If ecological resources are to be effectively protected from impacts of development, a careful, well-designed survey of the prospective area must be conducted to identify and characterize these resources before selection of specific corridors and sites for roads, pipelines, transmission lines, well-pads, power plants, and other facilities. An adequate survey will include, at a minimum, the following:

1) Acquisition and use of available ecological, geological, and hydrological literature and other information applicable to the prospect area;
2) Identification, characterization, and mapping of the major terrestrial plant and animal communities in the area, mapping of migration routes, and an evaluation of the potential sensitivity of biota to hazards of geothermal development;
3) Characterization and evaluation of soils and other geological surface features for susceptibility to erosion, sliding, slumping, and contamination-induced changes in soil chemistry.
4) Characterization and topographic mapping of aquatic ecosystems (both in the immediate vicinity and downstream of the proposed project) in terms of their gross hydrological, chemical, and biological features, and an evaluation of their potential sensitivity to geothermal development;
5) Identification, mapping, and if possible, quantification of especially sensitive, rare, unique, or critical habitats in the prospect area;
6) Identification, quantification (if feasible), and mapping of rare, threatened, and endangered species, and an assessment of their potential sensitivity to development. Table 4 summarizes the results of surveys at specific projects; and
7) Characterization of local climate and meteorology.

The information and data generated in the ecological survey can be used in conjunction with engineering and design criteria for the project to develop and implement a program of measures, including siting criteria, for mitigation of ecological impacts. All of the mitigative measures listed in the following checklist will not apply to all types of projects at all sites; rather, the results of the ecological survey as well as the nature of the project will dictate the appropriate mix of measures to be applied at a given prospect area. Specific measures that have previously been recommended for mitigating impacts at existing or proposed projects are listed in Tables 5 and 6.

Checklist for Siting-Related Criteria for Mitigation of Ecological Impacts

1. Avoid siting facilities on or adjacent to especially sensitive, rare, unique, or critical habitats or features (e.g. riffle areas in streams, seeps, springs, large trees), particularly those utilized by rare, threatened, or endangered species (may sometimes require directional drilling or well-clustering techniques).

2. Based on prevailing winds and other local meteorological conditions, site wells and cooling towers downwind of and at as great a distance as practicable from the most sensitive plant and animal receptors to minimize exposure to gases and cooling tower drift.

3. Minimize direct destruction of habitat by utilizing existing roads, canals, well-pads, and other existing disturbed areas, whenever practicable.

4. Where practicable, in coastal areas site geopressure facilities on chenier ridges or other upland areas rather than in wetlands or aquatic systems.

5. Avoid siting in locations especially susceptible to landslides and erosion.

6. Avoid, where practicable, major activities during periods most likely to disturb wildlife or fish (e.g. fish spawning seasons).

7. Avoid siting major facilities on prime or unique farmlands.

8. Haul potentially toxic wastes to an approved disposal site.

9. Site sedimentation, sump, and spill-retention basins in areas of relatively low ecological values but consistent with protection of aquatic ecosystems on and off-site.

10. Where practicable, replace ecological resources that must be compromised or destroyed with an equivalent substitute nearby (e.g. replacement of a wildlife watering hole with a concrete water storage basin as was done at one of the Geysers projects in California).

11. Establish and/or maintain an undisturbed buffer zone around geothermal facilities.

12. In coastal areas of the geopressured zone, align spoil banks parallel to natural drainage, and roads parallel to dune ridges; and permanently block canals when no longer needed;

13. Site transmission and pipeline corridors so as to minimize effects on sensitive habitats and species; provide diking and catchment basins as appropriate to intercept leaks or fluids from pipeline failures.

14. Avoid siting facilities in major migration routes and other important pathways for animal movements, or in areas of unusual animal activity.

15. Route transmission lines so as to reduce waterfowl collisions.

16. Top transmission towers with raptor perches to reduce electrocutions.

17. Avoid sites especially susceptible to landsliding and erosion based on geotechnical evaluation of potential well and plant sites in areas of steep topography.

Other Mitigative Measures

Other measures for mitigation of ecological impacts include:

1. Mufflers for noise reduction.

2. Drift eliminators on cooling towers.

3. Blowout preventers on well-heads.

4. Reinjection of spent geothermal fluid to reduce subsidence and harmful effects of surface disposal.

5. Fugitive dust reduction by wetting and other means.

6. Prompt revegetation of disturbed areas.

7. Establishment of a comprehensive spill prevention and countermeasure plan.

8. Plant designs and engineering (including installation of ring dikes and berms) to reduce potential for escape of spills.

9. Impervious liners for waste pits and sumps.

10. Minimization of erosion by gravelling or planking (coastal areas) roads.

11. Development of a plan for fire control.

Table 1. Major impacts predicted for site- and area-specific geothermal projects on land use and terrestrial ecology (excluding major accidents)

Project	Land area disturbed (ha)[a]	Prime farmland disturbed (ha)[a]	Endangered species affected[b]	Important features or habitat disturbed[c]	Damage from drift
		Geopressure[d]			
Dow Parcperdue	2	2			
Gladys McCall	2	0		X	
Sweet Lake	2	2		X	
Pleasant Bayou	2	0			
Blessing Prospect[e]	2	2		X	
LaFourche Crossing[e]	2	0		X	
Southeast Pecan Island[e]	2	0	X		
		Hydrothermal			
Heber Binary Cycle	9	9	X		X
Westmorland	40	0			X
South Brawley	80	2			X
Rorabaugh	10	0		X	X
Coso	4	0			
Baca	60	0	X	X	
Boise	5	0	X		
Raft River	45	0			
NCPA No. 2	12	0	X	X	X
Brady Hot Springs	2	0			
Beryl and Lund	56	0			X
Roosevelt Hot Springs	14	0			X
Hawaii	2	0			
Oregon Trail Mushrooms	4	4			
Marlin	1	0			
		Hot dry rock			
Fenton Hill	6	0		X	

[a] 1 ha = 2.471 acres.

[b] Includes listed or proposed, state and federal endangered, threatened, or rare plant and animal species which could be significantly affected.

[c] Includes features such as springs, seeps, and dens or nesting areas and habitat such as important wintering grounds, highly productive wetlands, or important feeding areas (e.g., grain fields) which could be significantly affected.

[d] Area disturbed could be somewhat greater if lengthy new access roads were needed.

[e] Information refers to worst impacts for a single site within a larger prospect area.

Table 2. Predicted and implied impacts on surface aquatic resources (excluding major accidents)

	Aquatic resource value	Water use	Water quality	Turbidity and sedimentation	Increased salinity	Direct habitat destruction	Altered aquatic communities	T/E[a] species	Altered circulation or flow
	Local/area	P[b]/T[c]/I[d]/A[e]	P/T/I/A	P/T/I/A	P/T/I/A	P/T/I/A	P/T/I/A	P/T/I/A	P/T/I/A
				Geopressured					
Pleasant Bayou	H/H	?[h]/?/L/0	H/M/M/L	H/L/L/0	0	0	H/M/M/L	L/M/?/?	L/H/?/?
Sweet Lake	H/H	M/M/?/?	H/M/M/L	H/L/M/0	0	H[g]/H/M/L	H/H/H/L	M/M/?/?	H[g]/H/?/?
Gladys McCall	H/H	M/M/M/L	M/M/M/L	H/L/M/0	0	H/H/M/L	H/H/M/L	M/M/M/L	M/H/M/L
Dow Parcperdue	L/H	0	H/L/M/L	H/L/M/L	0	H/H/M/0	H/L/H/L	L/L/L/0	H/H/L/0
LaFourche Crossing	H/H	?/?/L	0	H/M/M/L	H/L/M/L	0	H[g]/H/M/L	H/M/H/L	M/M/M/L
Southeast Pecan Island	H/H	?/?/L/0	H/M/M/L	H/L/M/L	M/H/?/?	M[g]/H/H/M	M/H/H/M	M/M/M/L	M/H/?/?
Blessing Prospect	L-M/H	0	M/M/M/L	M/L/L/0	0	0	L[g]/M/M/L	0	0
				Hydrothermal					
Hawaii Flow Test	[f]/[f]	0	0	0	0	0	?/?/0/?	0	0
Hawaii Research Station	[f]/[f]	0	0	0	0	0	?/?/0/?	0	0
Raft River Test Loop	L-M/L-M	0	M/L/M/0	H/L/M/?	0	H/M/H/0	H/M/H/L	0	L/H/?/?
Raft River Pilot Plant	L-M/L-M	0	M/L/M/0	H/L/M/?	0	H/M/H/0	H/M/H/L	0	L/H/?/?
Coso Well Test	L-M/[f]	0	L/H/?/0	0	?	0	L/H/?/0	0	L/H/?/0
Baca Ranch Demonstration	H/H	0	H/?/H/M	H/M/H/M	0	0	H/?/H/M	0	M/M/M/L
Marlin Direct Heat	[f]/M	M/L/0/0	M/H/M/L	M/L/M/L	M/H/L/L	0	M/H/M/L	0	0
Heber Demonstration	L-M/M-H	H/H/L/L	H/M/L/L	?	H/H/L/L	0	L/H/L/L	0	M/M/M/L
Brady Hot Springs	[f]/[f]	0	0	0	0	0	0	0	0
South Brawley	L-M/M-H	H/H/L/L	H/M/L/L	?	H/H/L/M	0	L/H/L/M	0	0
Beryl and Lund	[f]/[f]	0	0	0	0	0	0	0	0
Roosevelt Hot Springs	[f]/[f]	0	0	L/L/L/0	0	0	0	0	0
NCPA No. 2	H/H	H/L/L/L	M/M/L/L	M/M/L/L	0	0	M/M/L/L	0	0
Westmorland Development	L-M/M-H	H/M/L/L	L/M/L/L	?	L/H/M/M	0	L/H/M/M	0	0
Oregon Trail Mushrooms	L-M/L-M	0	0	?	0	0	0	0	0
Rorabaugh Lease	H/H	0	?	H/M/M/M	0	M/H/M/0	M/M/H/?	0	0
Republic East Mesa	L-M/M-H	0	0	0	0	0	0	0	0
Boise District Heating	M-H/M-H	0	M/M/L/L	?L/L/L/0	L/H/L/0	L/M/L/0	L/M/L/0	0	0
				Hot dry rock					
Fenton Hill	[f]/[f]	0	0	L/L/L/0	0	0	0	0	0

[a] Federally designated threatened or endangered species.

[b] P — probability of occurrence: 0 — zero; L — low; M — moderate; H — high.

[c] T — amount of time impact may last: 0 — zero; L — low; M — moderate; H — long-term.

[d] I — local severity of impact: 0 — zero; L — low; M — moderate; H — high.

[e] A — severity of impact over a wide area: 0 — zero ; L — low; M — moderate; H — high.

[f] There is an absence of perennial surface waters.

[g] If sited in wetlands or estuaries.

[h] Insufficient information to evaluate impacts.

Table 3. Potential accidents and their effects on aquatic resources

	Blowouts or major spills (P[a]/I[b]/A[c])	Flooding (P/I/A)	Altered circulation (subsidence) (P/I/A)
	Geopressured		
Pleasant Bayou	M/H/H	M/M/?	0
Sweet Lake	M/H/M	L/M/?	L/?/?
Gladys McCall	M/H/M	H/?/?	0
Dow Parcperdue	M/H/M	L/M/L	M/L/0
LaFourche Crossing	M/H/M	H/M/M	L/?/?
Southeast Pecan Island	M/H/M	H/H/M	L/?/?
Blessing Prospect	L/?[d]/?	L/M/L	M/?/L
	Hydrothermal		
Hawaii Flow Test	L/0/0	?/0/0	0
Hawaii Research Station	L/0/0	?/0/0	0
Raft River Test Loop	L/H/L	0	M/L/0
Raft River Pilot Plant	L/H/L	0	M/L/0
Coso Well Test	L/M/?	L?/L/0	L/M/0
Baca Ranch Demonstration	?/H/H	?	L?
Marlin Direct Heat	L/?/?	L?/?/0	L/0/L
Heber Demonstration	L?/H/L	0	L/M/0
Brady Hot Springs	L?/0/0	L/L/0	0
South Brawley	L?/H/L	?	?/H/?
Beryl and Lund	L?/L/0	?	0
Roosevelt Hot Springs	L?/0/0	?	0
NCPA No. 2	L/H/M	0	M/L/0
Westmorland Development	M/H/M	L?	L/H/?
Oregon Trail Mushrooms	L/L/L	0	0
Rorabaugh Lease	?/H/H	L/H/M	L/M/0
Republic East Mesa	L/L/L	L?/L/0	L/L/0
Boise District Heating	L/L/L	L?/L/0	L/L/0
	Hot dry rock		
Fenton Hill	0	?	0

[a] Probability of occurrence: 0 = zero; L = low; M = moderate; H = high.

[b] Severity of impacts on local aquatic resources: 0 = zero; L = low; M = moderate; H = high.

[c] Severity of impacts on area aquatic resources: 0 = zero; L = low; M = moderate; H = high.

[d] Insufficient information to evaluate the potential for accidents and their effects.

Table 4. Summary of important habitats and species potentially subject to damage in the areas of specific geothermal projects

Project	Endangered species	Habitat affected
	Geopressure	
Gladys McCall	None	Surrounding marsh
Sweet Lake	None	Rice fields used by waterfowl
Blessing Prospect	None	Grain fields, riparian woods
LaFourche Crossing	None	Marsh, cypress-tupelo swamp
	Hydrothermal	
Heber Binary Cycle	Flat-tailed horned lizard	Natural desert vegetation
Rorabaugh	Hot springs panic grass	Oak woodlands
Baca	Three state rare plants; salamander	Salamander and elk habitat
Boise	Proposed rare plant species (wild onion)	Woodland
NCPA No. 2	Proposed rare plant (jewel flower)	Seeps and riparian habitat
	Hot dry rock	
Fenton Hill	None	Elk habitat

Table 5. Examples of specific measures recommended for mitigating aquatic impacts of geothermal projects

Project	Mitigation measure
Dow Parcperdue	Shunt any uncontrolled release of brines away from sensitive wetlands to less sensitive Vermilion River
Gladys McCall	Use an existing well site and confine all activity to within site levee and existing plank road;
Sweet Lake	Align spoil banks parallel to natural drainage; permanently block canals after project completion; limit speed of canal traffic to reduce erosion and sedimentation
Southeast Pecan Island	Restore natural drainage by closing canals and breaching spoil banks after project termination; use existing reinjection wells
Westmorland and Baca Ranch	Cease irrigation of some agricultural land to limit water use
Raft River	Avoid riffle areas for pipeline crossings; use flexible pipe or joints to prevent pipeline ruptures in the case of subsidence
Rorabaugh	Restrict earth-moving operations to rainless days; design berms and sumps to contain potentially toxic spills
Marlin	Retain geothermal fluids in temporarily cooling/settling; construct stair-step waterfall for aeration of fluids
Beryl and Lund	Site wells away from playas or washes
Coso	Site wells away from springs and seeps

Table 6. Specific measures for mitigating impacts to land use and terrestrial ecology recommended for geothermal projects

Project	Mitigation measure
Heber	Cluster wells to avoid prime farmland Fence evaporation basin to discourage wildlife use Survey potential evaporation pond sites for, and avoid areas with, flat-tailed horned lizard
Westmorland	Route transmission lines to minimize waterfowl collisions
Baca	Avoid elk winter range Survey potential routes and sites for, and avoid areas with, salamander and endangered plant habitat
Boise	Survey potential site for, and avoid areas with, proposed endangered wild onion
Raft River	Maintain 50-m buffer on each side of stream
Beryl and Lund	Maintain 1-km buffer around butte raptor habitat
Rorabaugh	Implement measures to limit erosion and sedimentation Use drains to maintain water supply for wildlife Revegetate disturbed areas with native species

LIST OF FIGURES

Figure

1 Distribution of known geothermal resource areas in the coterminous United States.

2 Distribution of specific geothermal projects by resource type.

3-6 Ecosystems typical of geothermal and geopressured resources: southern California desert (Fig. 3), New Mexico high country (Fig. 4), Louisiana estuaries and wetlands (Fig. 5), Salton Sea (California) National Wildlife Refuge (Fig. 6).

7-11 Sources of potential ecological impact: steam and gas venting, Cerro Prieto, Mexico (Fig. 7); and Geysers, California (Fig. 8); roads and canals, Gladys McCall in wetlands of Louisiana (Fig. 9); surface discharge of geothermal and other effluents (Figs. 10 and 11).

MOST KGRA'S IN U.S. ARE IN WEST, BUT GULF COAST IS PROMISING

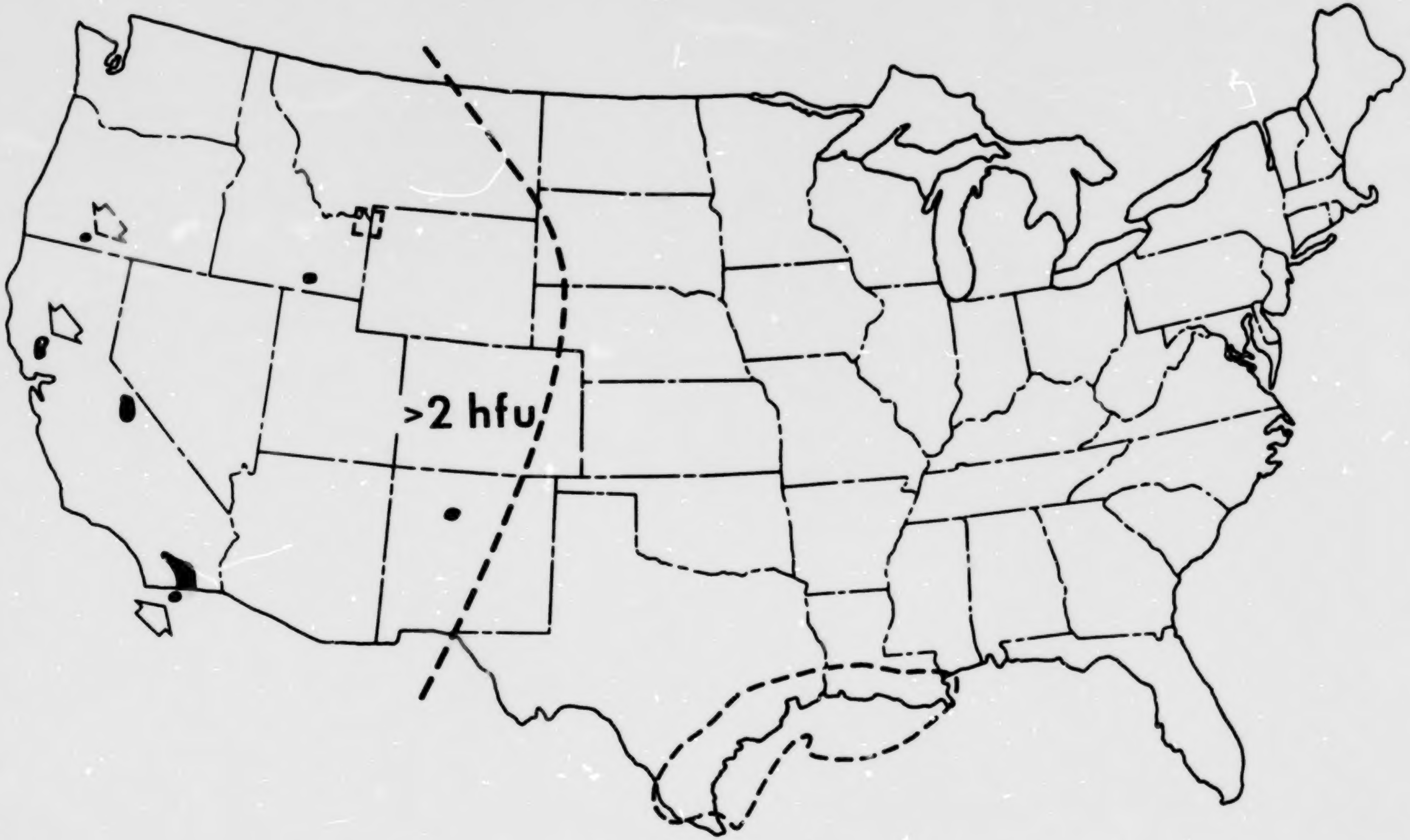

Figure 1

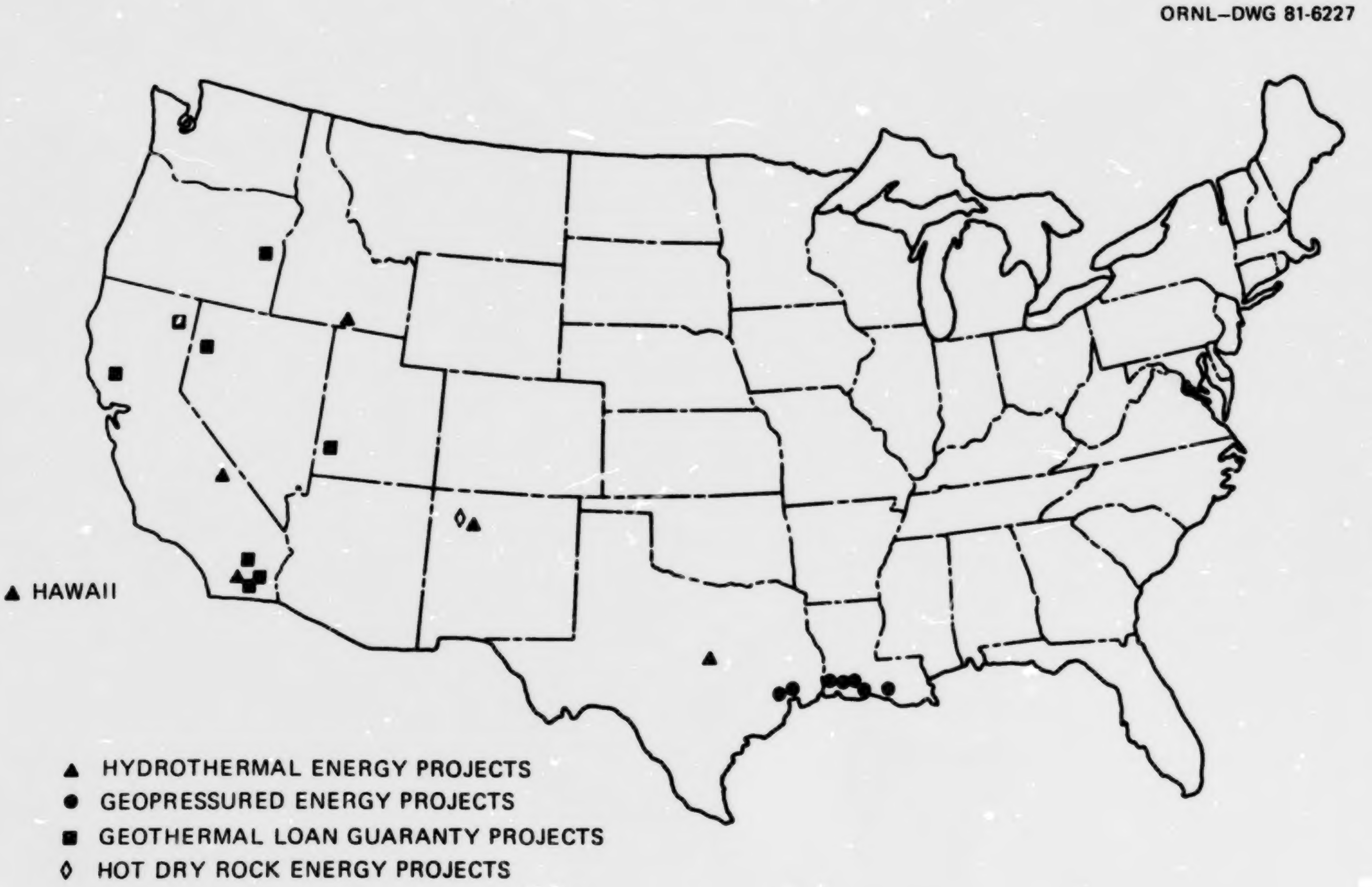
ORNL–DWG 81-6227
▲ HAWAII
▲ HYDROTHERMAL ENERGY PROJECTS
● GEOPRESSURED ENERGY PROJECTS
■ GEOTHERMAL LOAN GUARANTY PROJECTS
◊ HOT DRY ROCK ENERGY PROJECTS

Figure 2

Figure 3

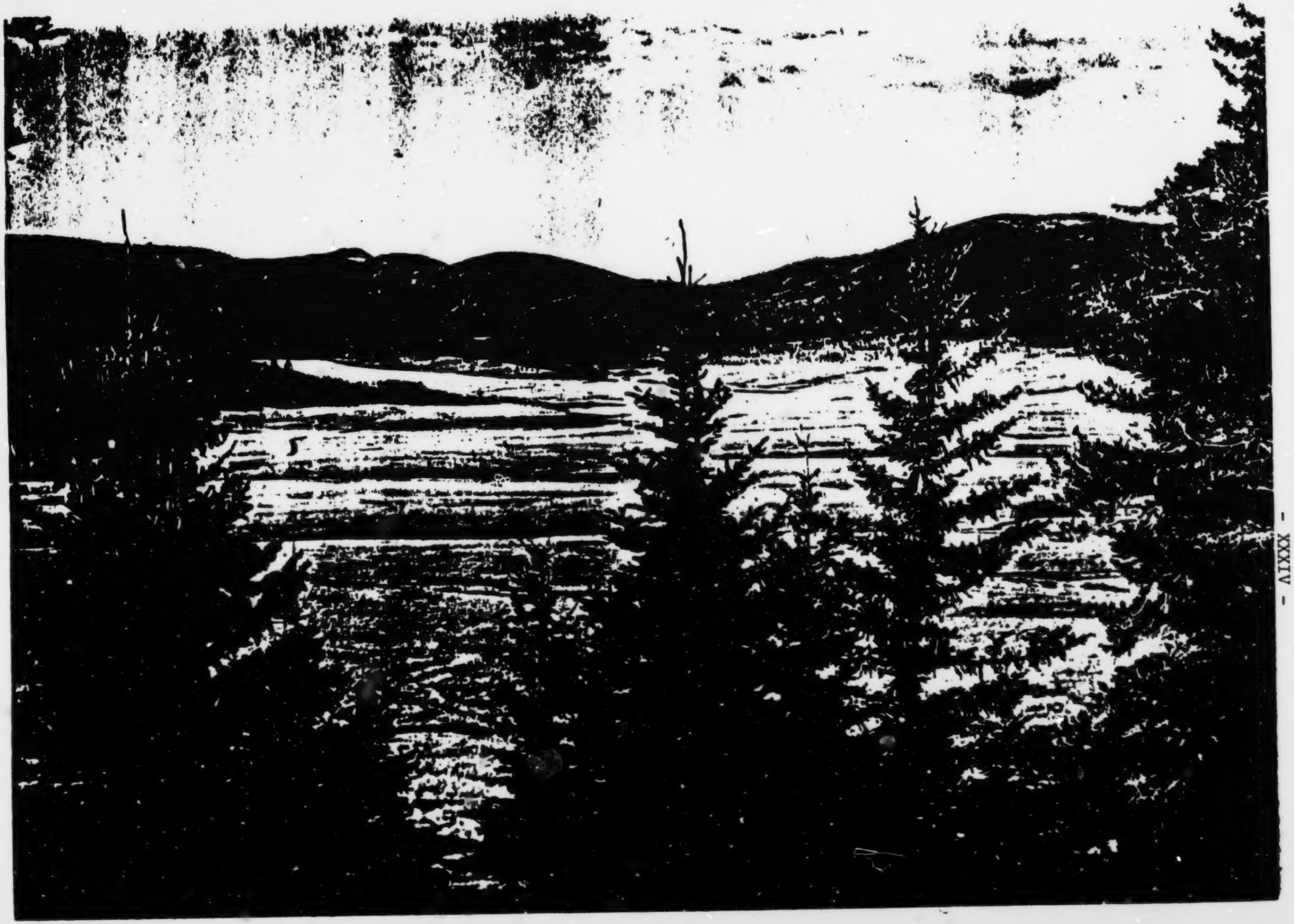

Figure 4

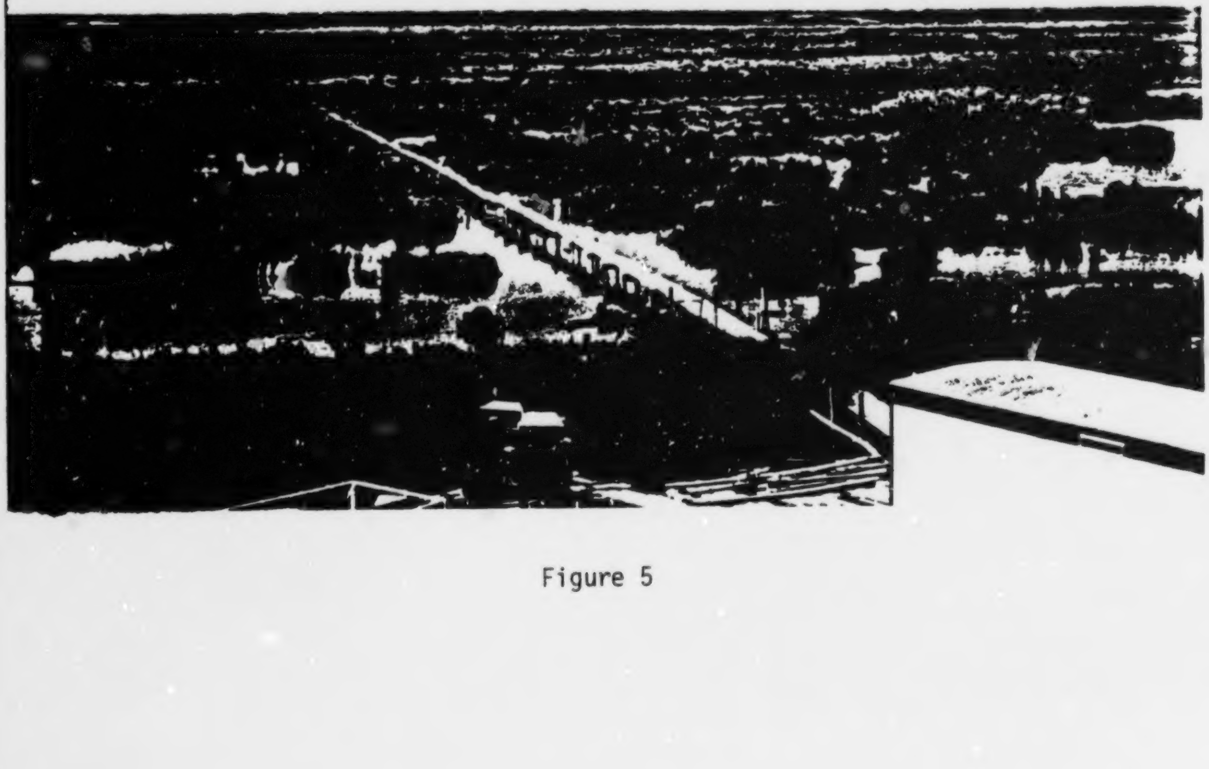

Figure 5

Figure 6

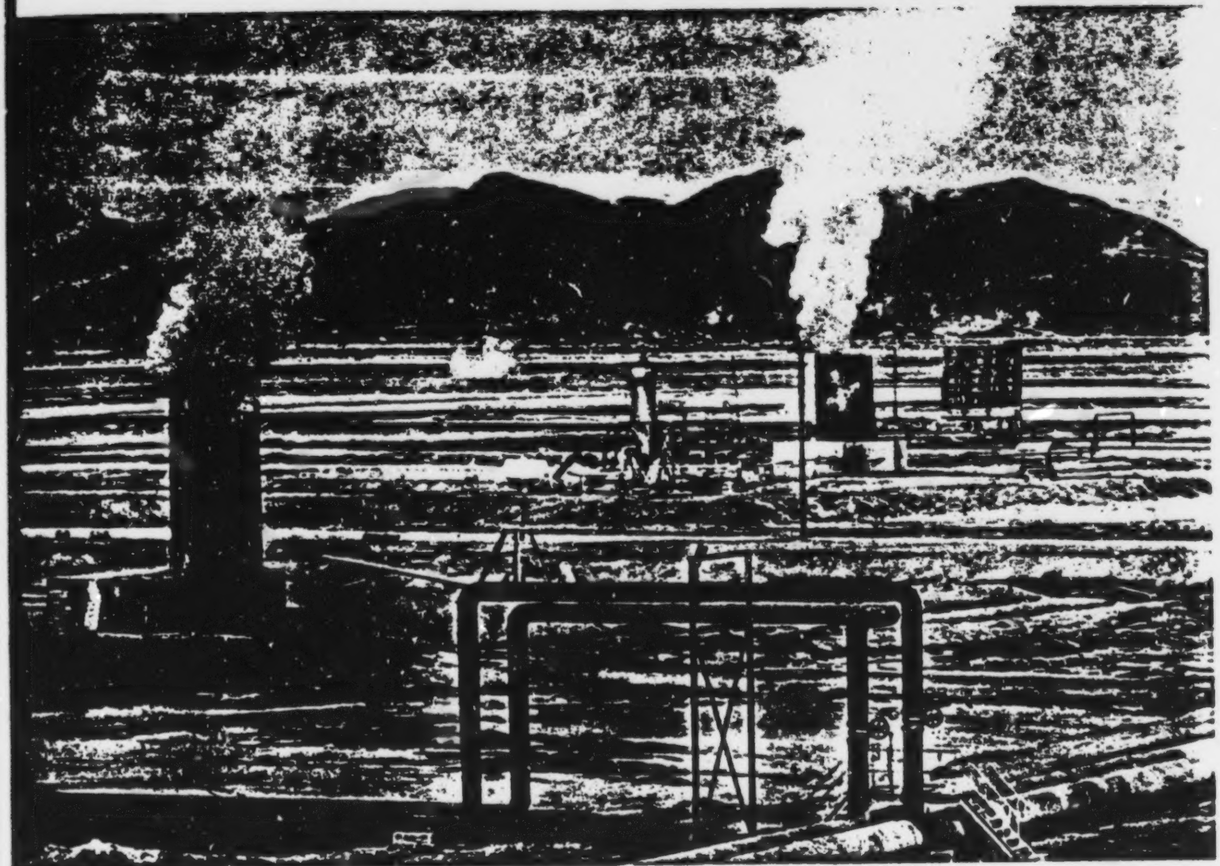

Figure 7

Figure 8

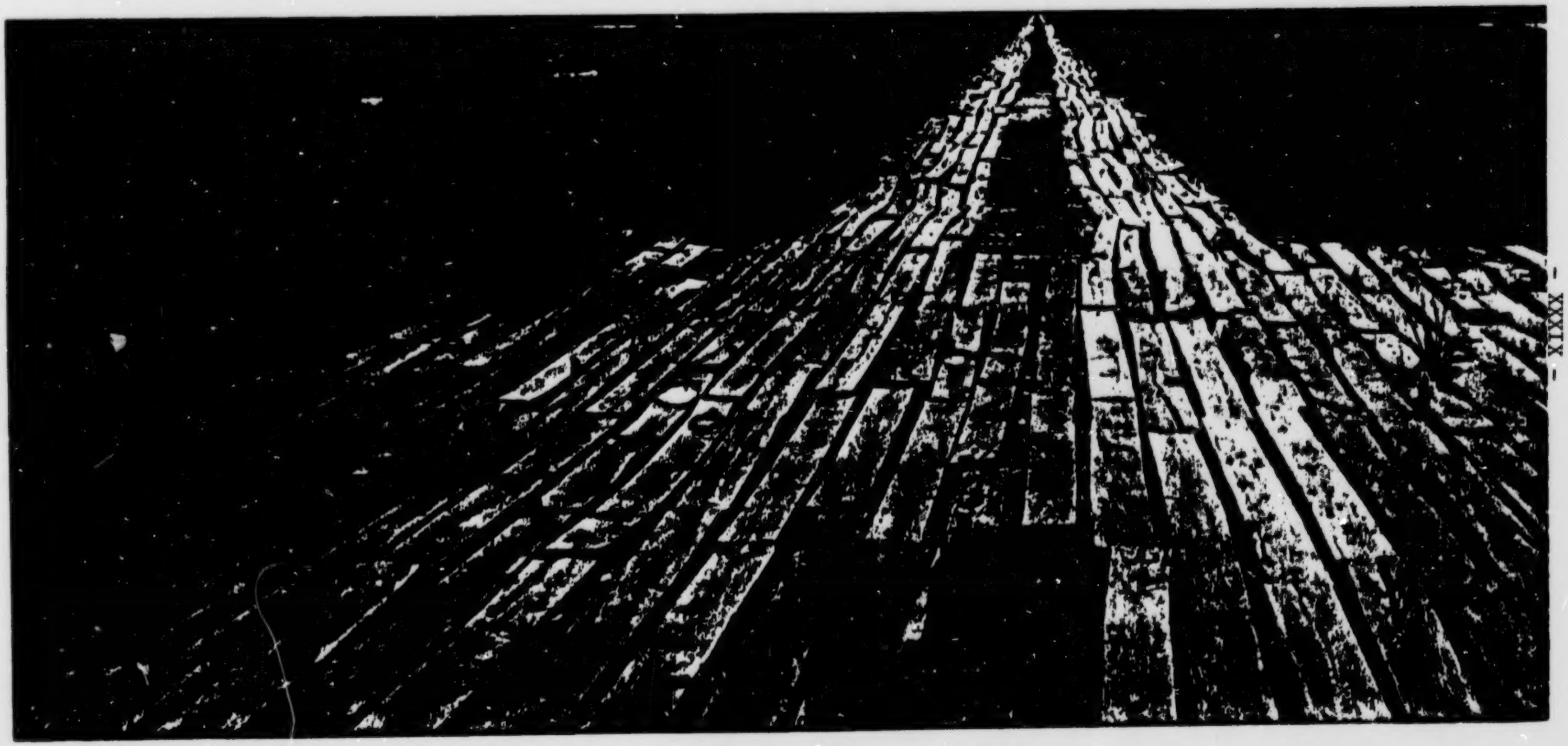

Figure 9

Figure 10

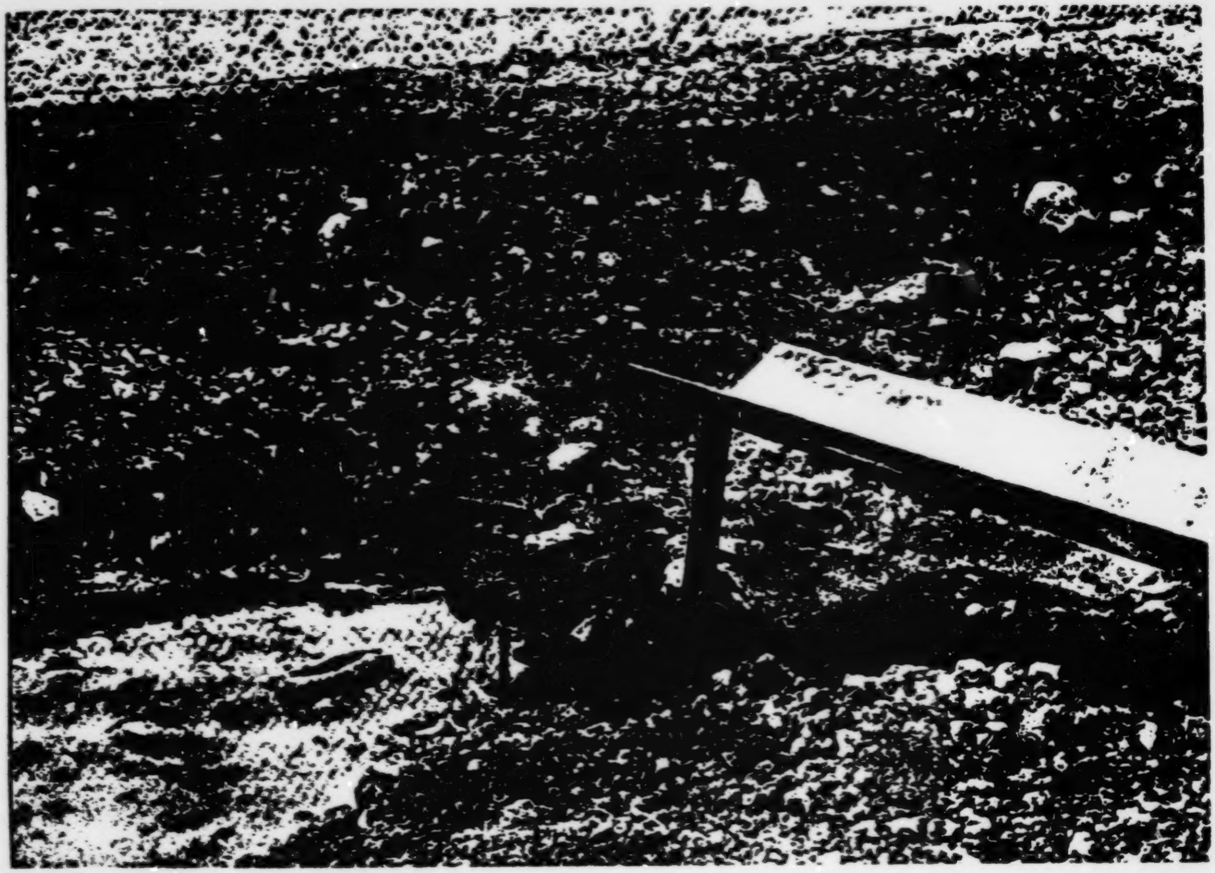

Figure 11

SESSION II B - SITING CASE STUDIES

ENVIRONMENTAL DECISION - MAKING DURING PLANNING, CONSTRUCTION AND EARLY OPERATION OF THE UPPER SALMON HYDROELECTRIC DEVELOPMENT IN NEWFOUNDLAND CANADA: A CASE STUDY

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ABSTRACT

Major decisions made during an environmental impact assessment historically have been clustered around submission of an impact statement. However, some critical decisions pertaining to refinement of mitigation and development of effects monitoring programs can be left until after the project has been approved. The pattern of decision-making during the assessment of the Upper Salmon Hydroelectric Development illustrates the benefits of an iterative and co-operative approach to problem-solving which can extend throughout construction and early operation of a project.

INTRODUCTION

The evolution of environmental impact assessment (EIA) in Canada progressed in the 1970's partly by design and partly through experience. Workers such as Munn (1975) and Holling (1978) concentrated on developing the theoretical policy, administrative, and scientific framework for EIA. Even though EIA was still evolving conceptually, proponents were being asked to undertake environmental assessments of their proposed projects. Proponents and their consultants began to develop a second framework based on experience. Consistent guidance was unavailable from government and there were many constraints such as costs and scheduling which had to be addressed. There was some useful feedback among proponents and EIA administrators during this time but concessions made by either party were minor and did not significantly affect the original tenets of EIA.

In the early 1980's,studies by Rosenberg and Resh *et al* (1981) and Beanlands and Duinker (1983) were able to compare the theoretical framework with environmental impact statements (EIS's) which documented the practicalities of completing an assessment. Both studies identified major weaknesses in EIA practices in Canada and made important recommendations concerning the need for better coordination among studies, better research design, and improvement of environmental effects monitoring. These studies, particularly Beanlands and Duinker (1983), have initiated a second phase of EIA evolution; the consolidation of the theory and practical experiences of the 1970's and early 1980's into an improved process with better communication among EIA practitioners and with a stronger emphasis on ecological principles.

There is no doubt that the submission of an EIS is the most significant evaluation point during an assessment. There is, however, a tendency to think

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of the EIS as the culmination of an EIA. The study by Rosenberg and Resh *et al*. (1981) which systematically analyzed sample EIS's reinforced this perception. Beanlands and Duinker (1983) also relied on reviewing EIS's but held workshops and examined case studies of projects which had gone past the EIS stage.

It is suggested here, based on experience in Newfoundland, that the importance of environmental decisions made during construction and operation of a project has been over-shadowed by those made during preparation and evaluation of an EIS. Development of a strategy for decision-making which de-emphasizes the importance of an EIS and recognizes that some decisions can and perhaps should be left until after the project has been initiated should be a priority during this next phase of EIA evolution.

The purpose of this paper is to document the environmental decision-making that occurred during the planning, construction, and early operation of the Upper Salmon hydroelectric development. Emphasis is placed on development of mitigation, monitoring and surveillance programs which occurred after the EIS and on the interaction between the proponent and the regulatory agencies.

THE UPPER SALMON DEVELOPMENT

The Upper Salmon development is located in southcentral Newfoundland, approximately 170 km southwest of Gander and 50 km northwest of St. Albans, on Bay D'Espoir (Figure 1). The Development exploits a portion of available head between the Meelpaeg Reservoir and Round Pond which are elements of the existing Bay D'Espoir hydroelectric project.

Before Upper Salmon, water flowed from Meelpaeg Reservoir through Crooked Lake and Great Burnt Lake and down the North Salmon River to Round Pond (Figure 1). Water from Cold Spring Pond flowed down the West Salmon River to Godaleich Pond and then into Round Pond.

A dam on the North Salmon River now diverts the water from Great Burnt Lake through two diversion channels into Cold Spring Pond. A dam on the West Salmon River creates a reservoir at Cold Spring Pond. Water from this reservoir is transmitted to the intake structure via a powercanal 3.6 km long. A penstock, approximately 455 m long, delivers water to the generating station on the shore of Godaleich Brook, a tributary of Godaleich Pond. The lower 1,000 m of Godaleich Brook has been excavated and serves as a tailrace transporting water to Godaleich Pond. A channel improvement was constructed below Godaleich Pond to control water levels in Godaleich Pond.

The powerhouse contains one Francis turbine which generates 84 MW of power and produces 522 GWh of energy utilizing an hydraulic head of about 51 m.

Access to the Development area was achieved by construction of a 50 km road from St. Albans. The 230 KV line from the Upper Salmon powerhouse parallels the access road for most of its length and terminates at the powerhouse at Bay

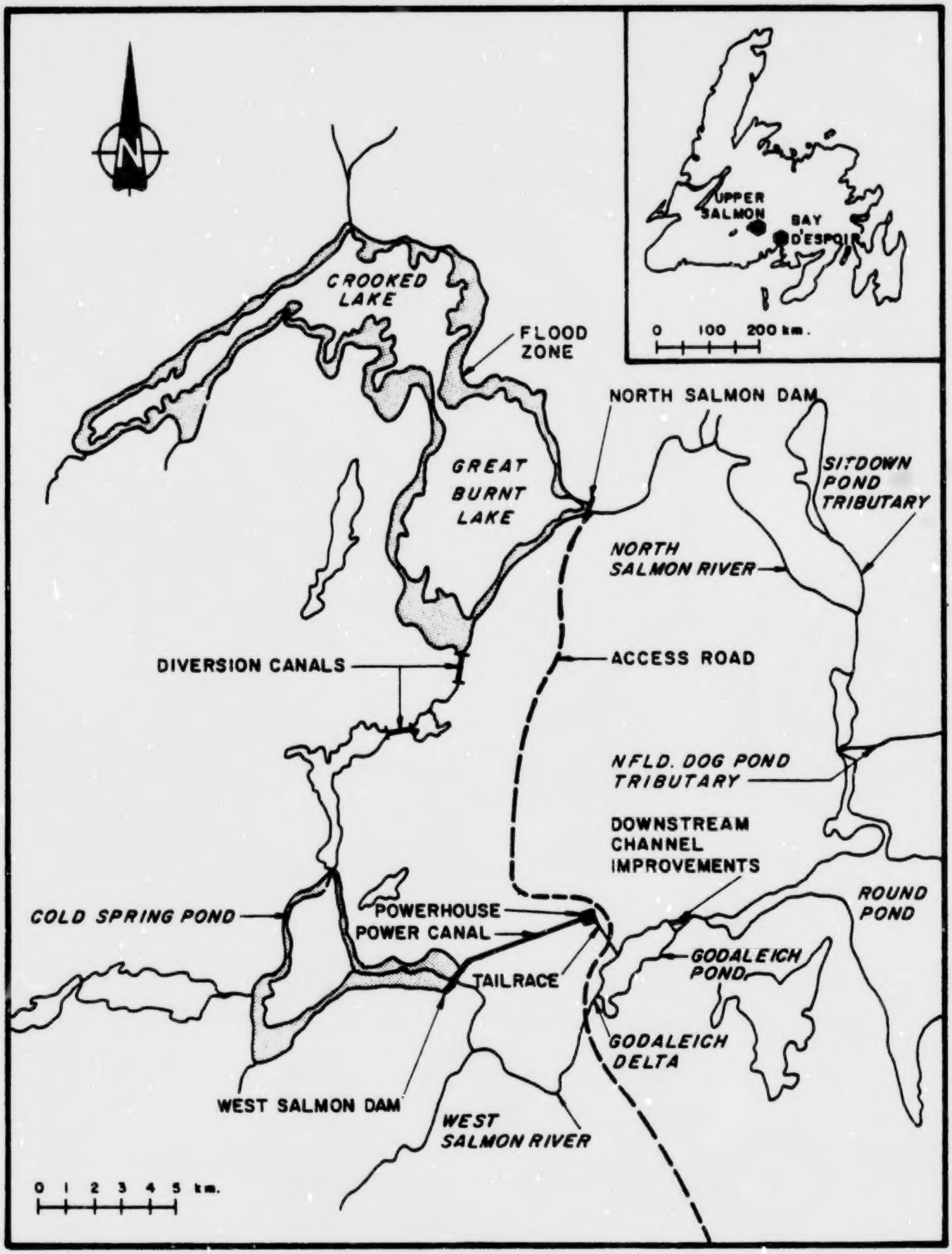

N
UPPER SALMON
BAY D'ESPOIR
0 100 200 km.
CROOKED LAKE
FLOOD ZONE
NORTH SALMON DAM
GREAT BURNT LAKE
SITDOWN POND TRIBUTARY
NORTH SALMON RIVER
DIVERSION CANALS
ACCESS ROAD
NFLD. DOG POND TRIBUTARY
DOWNSTREAM CHANNEL IMPROVEMENTS
COLD SPRING POND
POWERHOUSE
POWER CANAL
TAILRACE
ROUND POND
GODALEICH POND
GODALEICH DELTA
WEST SALMON DAM
WEST SALMON RIVER
0 1 2 3 4 5 km.

FIG. 1. THE UPPER SALMON HYDROELECTRICAL DEVELOPMENT

D'Espoir. Additional information on the Development is available in Sturge and McKechnie (1981).

BACKGROUND

In 1977, a comparison of projected power and energy needs in Newfoundland with existing generation capacity indicated that a new source of generation would be required before 1983. The Upper Salmon hydroelectric development was apparently the best available source of generation on the Island. Detailed engineering and economic feasibility studies were initiated in 1978 to confirm this assumption.

Preliminary environmental impact studies were undertaken in 1976 (Airphoto/Beak 1976) but the main EIA initiative was begun in 1978. The construction schedule indicated that the access road had to be started in the spring of 1979 in order to begin construction of the main civil works in the spring of 1980. Environmental studies undertaken in the summer of 1978, provided the provincial government with enough information to allow Newfoundland and Labrador Hydro (Hydro) to initiate construction of the access road as required by the schedule. Approval to construct the remainder of the Development was granted but was contingent upon the submission of an acceptable EIS. These decisions could be made out of sequence because of the EIA process in Newfoundland was still developing and, as a result, was quite flexible in its requirements. The EA Act was passed in late 1980.

The EIS was submitted to government in April, 1980. The Upper Salmon EIS was prepared using the results of seven separate environmental studies.

The studies investigated the potential impacts of the Development on fish, wildlife, forests, and historical resources and gathered information on other aspects of the surrounding biophysical and socioeconomic environments. Of all of the elements of the environment which were studied, three were judged to have special importance: fish; caribou; and the Godaleich Pond delta.

Pre-Development Environment

Inventory studies indicated that the lakes in the Upper Salmon area support large numbers of sport sized salmonids. The two major species are ouananiche (Salmo salar) and brook trout (Salvelinus fontinalis). These species use the excellent spawning and rearing habitat in streams around the Development. There is an estimated 7,000 units (1 unit = 100 m^2) of salmonid spawning habitat in the upper West Salmon River alone. Densities of juveniles in the West Salmon River are about 0.77 fish/m^2 which means that there may be as many as 550,000 juvenile salmonids in that River each year. There is also spawning and rearing habitat in the lower West Salmon River (750 units), Godaleich Brook (600 units), and the North Salmon River mainstem and tributaries (2,450 units). The quality of the estimated 1,440 units in the mainstem of the North Salmon River is questionable because of the impacts associated with the Bay D'Espoir hydro project.

Caribou (Rangifer tarandus) are seasonally present in the Development area in large numbers. The general pattern of caribou distribution was known in 1976 (Airphoto/Beak, 1976) and was confirmed during more intensive studies undertaken later (Manoney 1980). The large Grey River herd (about 5,000 animals) winters along the south coast of the Island. As spring approaches, they migrate northward and calve near Wolf Lake and Dolland's Pond about 20 km southwest of the Development area. Some calving has been observed near Cold Spring Pond. After calving, does and calves move into the Cold Spring Pond area and form post-calving aggregations during early to mid-June. In late-June, the postcalving aggregation begins to disperse through the Development area to summer range north of Upper Salmon (Figure 2). The Sandy Lake herd (about 200 animals) and the Pot Hill herd (about 400 animals) also frequent areas north and northeast of the Development.

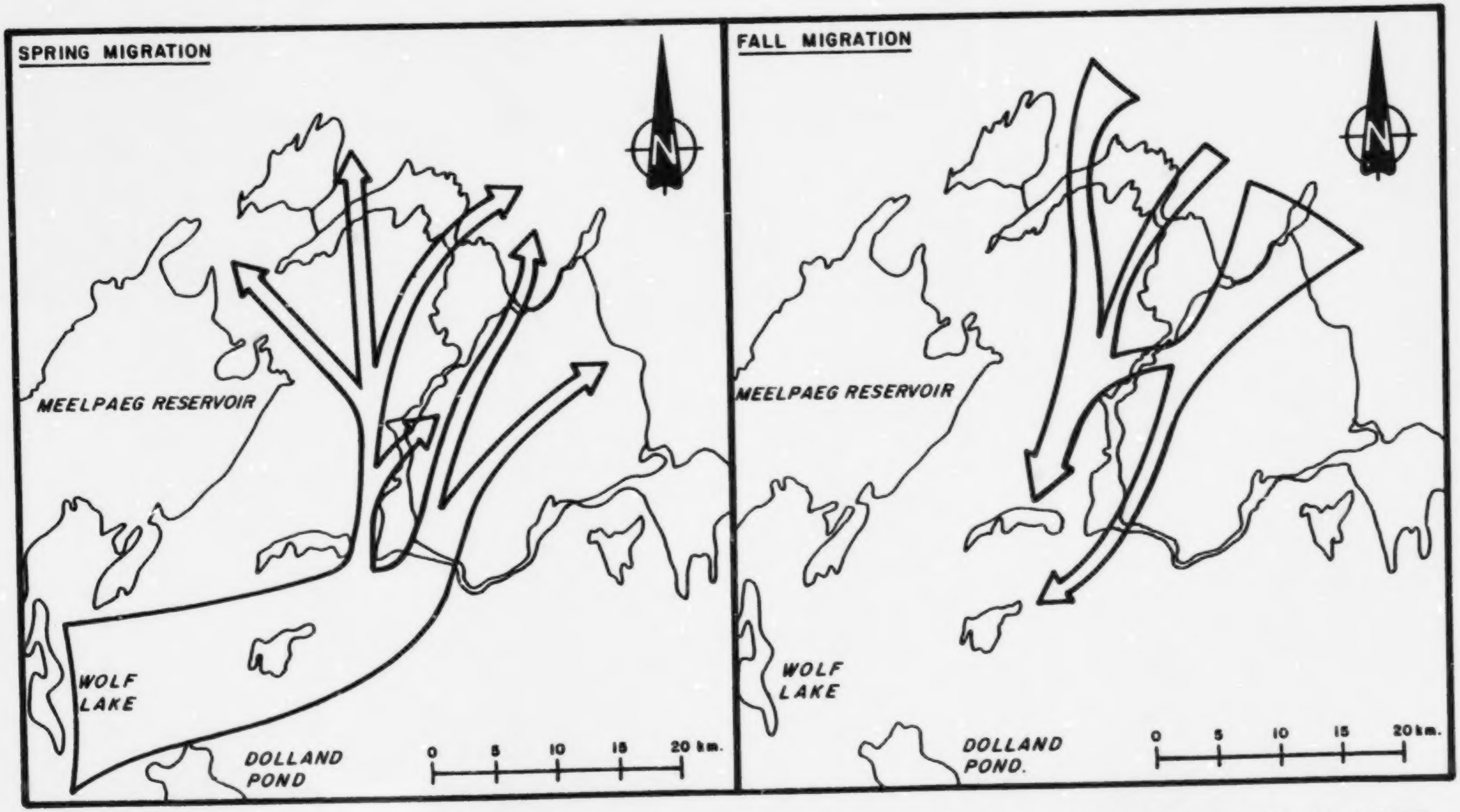
The Godaleich Pond delta, located at the junction of the West Salmon River and Godaleich Pond, is the most productive habitat for waterfowl and shorebirds in the Development area. Mammals also frequent the delta in densities higher than in surrounding areas.

Predicted Impacts

The Upper Salmon EIS predicted 43 different impacts. These were later tabularized and classified according to type (positive or negative), severity (minor, moderate, major), scale (local and provincial) and duration (short or long term) (Newfoundland and Labrador Hydro 1981).

The following major, long-term, detrimental impacts were predicted to occur as a result of the Development if no mitigation was undertaken:

1. Commitment of 5,000 ha of land for roads, civil structures and the reservoir;
2. Loss of 518 ha of merchantable timber;
3. Loss of 4,400 units of salmonid spawning habitat and 2,800 units of rearing habitat;
4. Destruction of the productive Godaleich delta;
5. Creation of possible barriers to caribou movements by various components of the Development;
6. Disturbance of caribou in their post-calving aggregation during construction;
7. Creation of a velocity barrier to migrating salmonids in the Lower West Salmon River; and,
8. Improved access to isolated resources, particularly caribou.


SPRING MIGRATION
MEELPAEG RESERVOIR
WOLF LAKE
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FALL MIGRATION
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WOLF LAKE
DOLLAND POND.
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5
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20 km.
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FIG. 2. GENERAL SPRING & FALL MIGRATION ROUTES OF THE GREY RIVER CARIBOU HERD THROUGH PROJECT AREA

Other predicted impacts and environmental risks were considered to be minor in comparison to the impacts listed above. The minor impacts included predicted changes in water quality and flow-through time in the lakes, increased pressure on community services, and increased likelihood of environmental contamination from siltation, oil spills and waste disposal, for example.

There are also positive impacts of the Upper Salmon Development. These include increased employment and business opportunities for the residents of the Bay D'Espoir area and, mostly importantly, generation of power and energy to supply the growing demands on the Island of Newfoundland.

Mitigation and Monitoring

The objective in developing a program of mitigation was not to propose a mitigative measure for every impact, but to reduce as much as is reasonable, the overall impact of the Development. This can involve rationalizing one or more major impacts which are impossible or impractical to mitigate (e.g. the loss of land to reservoir creation) in terms of the benefits of the project and can include mitigating many minor impacts which, when examined in the broad context, appear not to be important (e.g. siltation in a minor brook or garbage management in the camps).

Decisions pertaining to the route of the access road and transmission line and the location of certain structures such as the powerhouse were made early in the planning process after the environmental implications were discussed with the appropriate regulatory agencies. The rationale for these decisions is presented in Newfoundland and Labrador Hydro (1981).

Most of the ouananiche and brook trout spawning and rearing habitat in the vicinity of the Development is located in the upper West Salmon River. Loss of 1,650 units of salmonid habitat between Cold Spring Pond and the West Salmon dam was inevitable because of reservoir creation. It was predicted that the 2,480 units of salmonid habitat between a major tributary of the West Salmon River and Godaleich Pond would not be in jeopardy because of the influx of natural flows. The only habitat that could be protected was the 2,550 units (2,100 spawning and 450 rearing) between the West Salmon dam and the inflow of the main West Salmon River tributary. Hydro committed to design and construct a water release structure in the West Salmon dam to provide flows to protect this habitat. The amount of flow augmentation required to protect this habitat was suggested by Beak (1980) using Tennant's Montana methodology. It was thought that more study was needed to determine the optimum release strategy. Hydro agreed to determine an agenda for water release for government approval.

During the EIA, juvenile salmonids were discovered in two tributaries of the North Salmon River. It was unclear whether these fish were the progeny of adults which migrated from Round Pond or whether they resulted from adults that spawned downstream from the headwater ponds. The habitat in these tributaries amounted to 1,012 units. The EIS stated that Hydro would design and construct water release facilities in the North Salmon dam to protect downstream salmonid population and that a water release strategy would be developed and implemented subject to government approval.

The main goal of the mitigation measures pertaining to caribou was to minimize disturbance of the animals during construction and to design the elements of the Development to facilitate caribou migration through the area. The following commitments were made to reduce impact on caribou:

(1) Road surfaces would be kept as narrow as possible;

(2) The access roads would be designed with a low profile and drainage ditches would be kept shallow;

(3) In designated areas of the powercanal, back slopes would be 3:1 rather than 2:1;

(4) The penstock was to be covered and have 3:1 slopes;

(5) Access to the Development area would be restricted during construction;

(6) Fire arms would be prohibited on the site;

(7) Blasting would be restricted to times when caribou density within 1.6 km of the blast site is less than 100 caribou; and,

(8) Traffic and construction activities would be restricted during times when caribou were migrating across the roads.

Although the value of timber resources flooded because of reservoir creation did not warrant clearing the reservoir, it was agreed that selected clearing was necessary for specific environmental reasons. It was recommended in the EIS that the flooded zone around Cold Spring Pond and two sections on the northern part of Crooked Lake should be cleared to minimize interference with caribou migration through the Development area. A detailed description of the Upper Salmon reservoir preparation strategy can be found in Kiell (1982).

Studies in Europe and Alaska and observations in Newfoundland suggested that caribou are quite sensitive to human disturbance and to obstructions to migration (Klein 1971; Banfield 1974). Based on these experiences, it was suggested that construction of the Upper Salmon Development could have detrimental impacts on caribou, particularly the Grey River herd, by restricting migration between summer and winter ranges.

In 1979, as part of the EIA, a study was initiated to determine the migration and distribution of caribou in the Development area (Mahoney 1980) and to quantify the reproductive success and general status of the herds. The study was co-funded by Hydro and the Newfoundland Wildlife Division (NWD). The EIS states Hydro's commitment to continue of this study until two years after the Development becomes operational.

The greater than normal amount of water entering Godaleich Pond because of the Development would raise water levels and flood the delta unless the outflow capacity of the Pond were increased. It was proposed in the EIS that levels in Godaleich Pond would be maintained near normal by excavation of a 700 m long channel between Godaleich Pond and Round Pond to preserve the delta for use by wildlife. This action also reduced the tailrace elevation at the powerhouse thereby allowing further maximization of the Development's generating capacity.

It was possible that this downstream channel improvement would create a velocity barrier to spawning salmonids migrating from Round Pond to the West Salmon River. Given the importance of the spawning and rearing habitat in the West Salmon River, it was agreed that velocities would be kept below 1.2 m/s; a velocity through which salmonids can swim unimpeded.

Construction of the access road was initiated in 1979 and the main civil structures were begun in 1980. Because of experiences at Hinds Lake (Skidmore 1982), an on-site surveillance officer for Upper Salmon was hired to ensure adherence to environmental regulations and guidelines, conditions imposed upon construction through the EIS, and by subsequence government directives.

Refinement of mitigative measures and development of monitoring programs continued throughout construction. The progress of these discussions were reported to government and the public in May, 1981 (Hydro 1981).

The Development became operational in January, 1983. Some monitoring studies and rehabilitation activities are continuing and the Development is still being audited for unforeseen environmental problems.

DECISION-MAKING AFTER THE ENVIRONMENTAL IMPACT STATEMENT

The Upper Salmon EIS was reviewed by government in the spring of 1980. Based upon this review, certain environmental conditions were required to be added to the environmental protection commitments made by Hydro. As construction of the main civil works began, efforts were underway to refine and implement the environmental commitments related to the Development. Further assessment and monitoring tended to focus on fish and wildlife concerns. On-site surveillance developed to a level significantly greater than at previous projects for both Hydro and for government.

Fish

The West Salmon River. Beak (1980) undertook field studies to develop a water release strategy for the West Salmon River as specified in the EIS. Cross-sections were taken of the River and hydrological data from nearby stream gauges was analyzed to refine estimates of water release needed for adequate habitat protection. Although it was acknowledged that flow augmentation of 50% mean annual flow would provide adequate protection for all life history stages of fish in the River, it was suggested that this amount of water might be excessive at certain times of the year and that this was not justified in terms of lost generation to the Development. Beak (1980) recommended that 30% mean annual flow (2.6 m^3/s in summer and 1.3 m^3/s in winter at the dam) would be an optimal flow strategy. They stated that this flow regime should provide good protection to juvenile salmonids, and reasonable protection to incubating eggs.

Hydro accepted the consultant's recommendation and submitted it to the Department of Fisheries and Oceans (DFO) for review. In early 1981, DFO agreed that 30% mean annual flow provided acceptable habitat protection. Engineering design of the water release structure was completed based on these flow requirements.

Water release is a very expensive mitigative measure for a utility to implement. At the Upper Salmon Development, water release in the West Salmon River is equivalent to 8.0 GWh of lost energy generation on the system. This is valued at between $2 and $4 million over the planned life of the Development (60 years) depending on such economic variables as interest rates, and projected future means of generating equivalent energy.

In 1981, Hydro suggested that there may be more economical ways of mitigating or compensating for fish habitat losses than by water release. Although DFO made it clear to Hydro that such a compensatory approach was not ideal in light of their habitat protection policies, they agreed to consider compensation proposals from Hydro.

A consultant was commissioned to investigate alternative ways of mitigating or compensating for lost fish habitat on the West Salmon River. They recommended that construction of a hatchery near Bay D'Espoir which would produce 90,000 ouananiche and 9,000 brook trout fingerlings was the preferred option (ShawMont 1982). These fish would then be released into the water bodies in and around the Development. A cost benefit analysis of the hatchery versus water release, however, revealed that construction and operation of a hatchery would be marginally more economic than water release. Hydro decided to abandon this potential compensation measure because of uncertainties associated with operation and maintenance of a hatchery as compared to maintaining a water release program.

The West Salmon dam is located about 4.0 km downstream of Cold Spring Pond. Salmonids from this Pond which utilize the West Salmon River for spawning and rearing would, therefore, lose the use of 1,650 units of habitat because of reservoir creation and be denied access to West Salmon River habitat below the dam. This was identified as a major impact on Cold Spring Pond salmonid stocks. Similarly, spawning salmonids from downstream water bodies would be denied access to habitat above the dam. This reduction in habitat could adversely impact upon salmonid stocks downstream of the Development.

DFO accepted that loss of 1,650 units of habitat above the West Salmon dam was not mitigatable and that the magnitude of this impact was unknown. They indicated a need to determine the use of the West Salmon River for reproduction by Cold Spring Pond salmonids and the use of habitat above the dam by salmonids from downstream water bodies in order to better evaluate potential impacts of the Development on fish. In 1980, Hydro agreed to undertake this study program.

Two, two-way counting fences were installed at the future West Salmon dam site and at a site on the River about 0.8 km downstream from Cold Spring Pond. In this way, a large percentage of the fish moving in the West Salmon River near the dam could be captured and tagged in order to document migration patterns. Results, after adjustments were made to accommodate fish movement before and after the installation of the fences, showed that a possible total of 11,500 ouananiche, 2,600 brook trout, and 200 arctic char had moved into, stayed in, or moved out of the study area (Beak 1981). Actual capture data indicated that ouananiche (1,974), brook trout (621) and arctic char (147) moved out of Cold Spring Pond to spawn in the West Salmon River. Ouananiche (2,156) and a smaller number of brook trout (76) were observed to move upstream through the dam site presumably to the habitat in the River between the dam site and Cold Spring Pond.

Generally, tne study confirmed that the West Salmon River was important for salmonids in the Development area. However, the magnitude of the impacts on fish stocks in Cold Spring Pond tnat would result from the construction of the West Salmon dam could only be prediced indirectly from this study.

Hydro agreed that water velocities in the downstream channel improvement should not exceed 1.2 m/s. After construction of the Development was approved, stream profiles were taken and velocities at 29 locations on the lower West Salmon River between Godaleich Pond and Round Pond were measured. A simple backwater model was then used to simulate velocities at these locations assuming average plant flows plus average natural flows. Results from this modelling suggested that there were three potential velocity barriers to fish migration.

In the spring of 1982, detailed studies were undertaken to more clearly identify problem areas and to consider potential mitigative measures to reduce velocities. Although there were predicted to be general areas where velocities could be a problem to fish migration, there were places within these areas, for example along the river banks, where velocities should be passable under most conditions (Acres 1982). Mitigative measures, such as streambed modifications, were proposed that would further reduce velocities in the problem areas.

In the fall of 1982, Hydro and DFO met to discuss the direction of future work in the downstream channel area. Hydro suggested that there was a reasonable chance that salmonids could migrate through the downstream channel improvement area to spawn in the West Salmon River. DFO agreed that the data provided by Acres (1982) demonstrated that velocities may not be as critical as originally anticipated but wanted documentation that fish migrations were not being halted. Hydro proposed to undertake a study in the fall of 1983 to determine whether fish were successfully migrating through the area and requested that DFO defer a decision on mitigation requirements until the results of the study were obtained.

Hydro designed a study which would determine whether fish were successfully migrating through the channel improvement area to the West Salmon River above Godaleich Pond. Counting fences were again used as the main tool for monitoring fish migrations. The results of the study are currently under review by DFO and Hydro. Negotiations and further decisions are pending.

North Salmon River. Studies were initiated to develop a water release strategy for the North Salmon River as stipulated in the EIS. Hydro suggested in late 1980 that because of previous impacts on the North Salmon River, a water release strategy should concentrate on providing transportation water for fish migrating from downstream lakes and reservoirs, up the North Salmon River and into the tributaries to spawn. DFO agreed with this suggestion on the grounds that provision for habitat maintenance flows would be excessive given the probable habitat deterioration that had already occurred. Based upon this decision, the water release facility in the North Salmon dam was designed to pass transportation flows as specified by Tennant's Montana methodology.

It was important to know whether juveniles in the North Salmon River tributaries were the progeny of adults from downstream or upstream. If adults from downstream lakes were not spawning in these tributaries, then even the transportation water would be unnecessary. In 1982, Hydro undertook a study to determine the origin of adult salmonids which were spawning in the North Salmon River tributaries. Also investigated were possible barriers to salmonid migration that would result from dewatering the River's mainstem.

Two-way counting fences were constructed on the Newfoundland Dog Pond and Sitdown Pond tributaries. During the period when the fences were operating, it was demonstrated that adult salmonids were migrating upstream from lakes and reservoirs to these tributaries via the North Salmon River. From this, it became apparent that it may be necessary to provide transportation flows in the mainstem.

Hydrological analysis suggested that in the area of the two tributaries natural runoff below the dam should provide sufficient flows to accommodate fish migration. IEC-Beak's (1983) study predicted that there was possibly one potential barrier to fish migration that could result from dewatering. This potential barrier was located between the two tributaries on the mainstem.

In early 1983, DFO and Hydro reviewed the results and implications of IEC-Beak's (1933) study. Hydro proposed to wait until the North Salmon dam was in service to evaluate the consultant's predictions that transportation water may not be required on the North Salmon River. DFO agreed with this approach. In the spring of 1983, following closure of the North Salmon dam, measurements were made in the River near the possible barrier. It was concluded that transportation flows were adequate to allow access to the tributaries. The measurements were taken again that fall to confirm this conclusion. DFO waived the need for water release from the North Salmon River dam.

Caribou

Distribution, Migration and Population Characteristics. The co-operative study between Hydro and NWD was initiated in 1979, continuing throughout construction and the first two years of operation as specified in the EIS. In each of the years between 1979 and 1984, radio collars were fitted to an average of approximately 57 caribou in the Development area. These animals frequently were located during the life of the transmitters which operate for up to two years. Each spring, herd census and classifications were undertaken to monitor the population characteristics of the herds. Further detail on the methodologies and preliminary results are found in Mahoney (1980) and Mahoney (1983) and contributed to compilation of Figure 2. The study is due to terminate in the spring of 1985.

Some minor changes in migration and distribution patterns were detected but no major impact on the herd has been observed which could be attributed to construction of the Development. The Grey River herd animals still successfully move between the winter and summer ranges and herd population characteristics showed no significant changes among years.

Caribou Behaviour. From 1981 to 1983, Hydro also examined the reaction of caribou to the Development at the group and individual level as opposed to the herd level in order to identify and evaluate more specific impacts to assist in the development of effective mitigative measures. This was accomplished by systematically observing the activities of caribou near the Development (the experimental area) and in control areas. The time devoted by caribou to distinct activities such as feeding, lying, standing, and running was used to prepare activity budgets for animals in the experimental and control areas. Disturbances or harassment can alter activity budgets by increasing the incidence and duration of unproductive activities. It was hypothesized that if caribou were disturbed by construction activities it would be reflected in their activity budgets. A similar study design was used to examine the reaction of caribou to the Trans-Alaska Pipeline and haul road (Roby 1978). In addition, the reaction of caribou to Development components was recorded opportunistically.

The data from this study are presently being analyzed and it is premature to discuss the results. However, it would appear that the caribou generally reacted to the Development by remaining what they considered a "safe" distance from various disturbances. By doing so, they were able to minimize the impact of the Development on their activity patterns.

Work Stoppage in the Presence of Caribou. Hydro agreed in the EIS to restrict blasting to times when the number of caribou within 1.6 km of a blasting site was known to be less than 100 caribou. A procedure described in Hydro (1981) was adopted and implemented during the first construction year of 1980.

As the Development continued, it was decided that similar protection was required for other construction activities such as vehicular traffic on roads, construction at the various civil works areas and at borrow pits and quarries. Hydro proposed a broader set of criteria to be implemented during 1981. The criteria varied depending on the sensitivity of the life history stage occurring at the time of the activity; calving (May through June 15), post-calving aggregation (June 15 to July 1) and migration (July). More protection was afforded to caribou during calving than was provided during post-calving and migration because animals are more sensitive to disturbance at that time. The criteria also had provision for an early warning system so that project managers could be alerted that a significant number of caribou were moving into an area and that construction activities might have to be temporarily halted. When caribou were moving through the area counts were taken from a helicopter daily, whenever weather permitted, to locate the animals in reference to the Development activities and to determine whether certain elements should be shutdown to prevent adverse impacts on caribou. The NWD approved the criteria prior to implementation. Brazil (1983) described how the criteria were implemented.

The implementation of the criteria helped reduce the potential impact of the Development on caribou by facilitating migration through work areas. The NWD suggested that the criteria did not offer enough protection (Brazil 1983) and concluded that the only way to allow caribou to pass through the Development area undisturbed was to prevent any construction activity during the post-calving and fall migration. Hydro, however, contends that the criteria were adequate protection and added some consistency to decision-making during construction.

Godaleich Delta

The Newfoundland Department of Environment required certain monitoring studies to be undertaken as a condition of approval for the Development. One of the studies involved determining the success of the downstream channel improvement as a means of preserving the valuable wildlife habitat at the Godaleich delta.

The delta has evolved and is maintained by the natural fluctuations in water levels in Godaleich Pond and by sediments transported to the site by the West Salmon River. The downstream channel improvement structure maintains average water levels in Godaleich Pond but it does not simulate the seasonal fluctuations normally experienced in the region. Also, the amount of water in the West Salmon River has been reduced, thereby, decreasing its ability to transport sediments. Therefore, the delta will not be maintained indefinitely. Hydro developed a monitoring study to test the hypothesis that the delta would succeed to a terrestrial ecosystem over time.

The Godaleich delta study is by necessity a long-term commitment. It is not known how long it will take to prove or disprove the hypothesis. It was decided to include a stipulation that study design and need be reviewed periodically. The first review will be held in 1984 after three field seasons.

The study emphasizes three aspects of the delta: wildlife (waterfowl and shorebirds); vegetation; and hydrology. The Canadian Wildlife Service contributes personnel to undertake wildlife surveys. These surveys are conducted at least three times annually. The vegetation work is being conducted by members of the Canadian Forestry Service. Surveys were completed in the first two years but it was decided that a vegetation survey was not necessary in the third year of the study. Hydro personnel are taking hydrological measurements and monitoring changes in water quality in and around the delta.

Surveillance

Construction of a development the size of Upper Salmon concentrates a great number of diverse activities into a very short time and into a small geographical area. This enhances the potential of environmental degradation through accident oil spills, or siltation of streams, for example. Also, there can be impacts caused by clearing of land for camps, structures, reservoirs and extraction of construction materials from borrow pits and quarries. These are usually relatively small individual impacts but, left unchecked, they can accumulate and present a serious problem. A Surveillance Officer was installed at Upper Salmon to promote government and Hydro policies and guidelines designed to reduce these impacts.

When the Development was approved by government, a similar on site surveillance position was created to report to a Surveillance Committee comprised of representatives of affected Provincial and Federal resources agencies. The Surveillance Committee was to be chaired by the Department of Environment. The purpose of this Surveillance Officer was to document whether Hydro was complying with its environmental commitments on site.

Whether these Surveillance Officers have had a positive effect in reducing environmental impact is difficult to measure. Use of environmentally acceptable construction practices was enhanced and the on-site environmental personnel were effective in reducing the overall impact of the Development. The Surveillance Officers were also responsible for implementing the caribou criteria. Surveillance is now an integral part of environmental management during construction of hydroelectric and other large projects (Langford 1983; Baker 1983).

DISCUSSION

EIA processes adopted in the 1970's, concentrate on implementing procedures which culminate in the preparation and review of an EIS. Most legislation and policies regarding EIA have little provision for follow-up during construction and operation of a proposed project. This skews the pattern of environmental decision-making (Figure 3) into perhaps two or three years of project feasibility planning even though a project's life from conceptualization to abandonment might span decades.

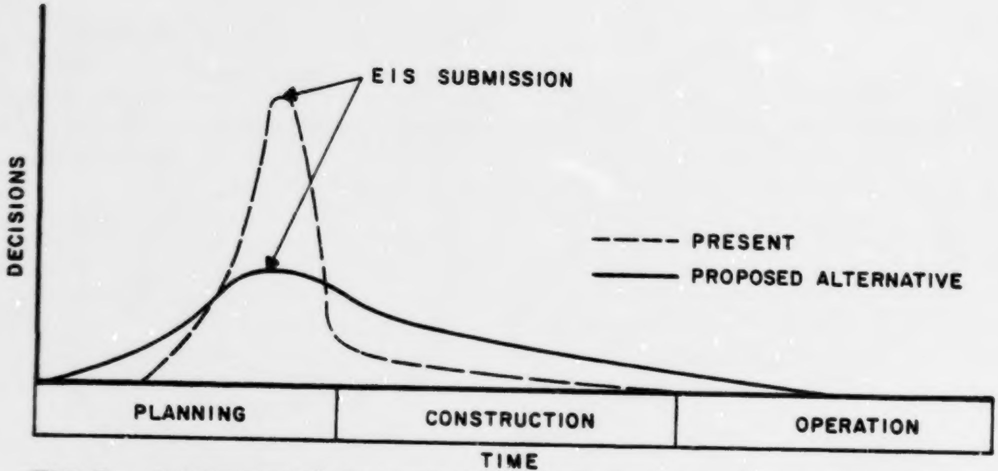

FIG. 3. PATTERNS OF ENVIRONMENTAL DECISION MAKING DURING AN IMPACT ASSESSMENT

There is an alternative decision-making practice which would produce a less skewed pattern (Figure 3). Beanlands and Duinker's (1983) report is likely to promote changes in decision-making toward this alternative. Their recommendation regarding a more prominent role for environmental effects monitoring programs in EIA for example, has already spawned development of new policy within the federal government. These policies may include provisions for formally communicating study results, keeping the public informed of the progress of monitoring programs, and making changes in or implementing mitigation based on the results of the environmental effects monitoring programs.

The Upper Salmon case represents an example of this alternative decision-making pattern. It is not suggested that this occurred because of a direct initiative of either Hydro or of government. Some environmental decisions were made under the pressure of time and political expediency but these are common problems that arise with every project. This revelation does not, however, reduce the significance of the lessons that can be learned from the case study.

The major decisions or recommendations made in the Upper Salmon EIS were of a general policy nature. First, it was determined that a new generation source was needed in order to meet future energy needs on the Island and that the Upper Salmon Development was the best available alternative. Second, it was suggested that the benefit of the Development outweighed the potential environmental impacts and that it was a reasonable resource management decision to proceed with the undertaking. Third, valued resources were identified (fish habitat, caribou, the Godaleich delta) and proposals were made to mitigate, and in some cases, monitor predicted impacts. This provided government and the public with information needed to evaluate the proposal and to decide whether to give approval for the Development.

Commitments to mitigate and monitor predicted impacts on what Beanlands and Duinker (1983) call valued ecosystem components should be described generally in an EIS. To use an analogy, engineering feasibility studies on hydroelectric projects are intended to provide certain information on the proposed project. They attempt to provide cost estimates for the undertaking (+/- 10%), determine whether material is available on site for construction of the structures, obtain preliminary design of key structures, and confirm hydrological and geological assumptions about the project area. Detailed engineering design is completed after a decision is made to proceed with the scheme. EIS's cannot be expected to and need not describe all proposed mitigative measures or monitoring programs in great detail because there is ample time to detail these after project approval. At the Upper Salmon Development a commitment to release water on the West Salmon River was made without defining the amount of water to be released or without designing a structure in detail.

Decisions relating to activities which, according to the project schedule, are initiated quickly after approval must be more specific and can be included in the EIS in detail. Route and site selection often fall into this category. In the case of Upper Salmon, the location of the powerhouse and access corridors were determined very early in the planning phase. These decisions were made so early that it was not obvious in the EIS that they received environmental evaluation and that government participated in the decision-making process.

Good working relations and co-operation between a proponent and the various government agencies are critical to the success of this alternative decision-making strategy. If a proponent consistently battles the fact that environmental protection is a necessary element of the planning, construction and operation of a large undertaking, then confrontation arises. In a confrontation atmosphere, governments are forced to regulate and impose their will on the proponent. If Hydro had taken a confrontation stance on the North Salmon River, for example, it is likely that water would be being released from the North Salmon dam today. Hydro and DFO engaged in an interative decision-making process to the advantage of both agencies. Hydro will not be releasing water at the North Salmon and DFO is satisfied that the fish resources in the River's tributaries are being adequately protected.

Hydro and the NWD entered into a co-operative relationship early in the EIA.

This included joint funding of effects monitoring programs (caribou migration and distribution studies) and data sharing (caribou behaviour study). Hydro and the NWD (Mahoney, 1983) agree that this arrangement worked well in this case. There were problems with such a close relationship, however. Issues such as editorial rights, quality control, data interpretation and study management developed which strained the relationship at times. A close relationship between a proponent and a government agency can also hamper decision-making because neither party is sufficiently aloof from daily events to make important decisions which affect the other agency.

Environmental effects monitoring studies can serve a useful purpose by gathering information to document the magnitude of mainly unmitigatable impacts (caribou distribution and migration studies) to evaluate the success of mitigative measures implemented during the project (Godaleich delta study), and to determine likely candidates for development of needed mitigation (caribou behaviour studies). Although all of these effects monitoring studies are not yet complete and, therefore, the benefits not fully realized, there is a more relaxed feeling among decision-makers as a result of the effects monitoring programs. For example, studies at Upper Salmon suggest that caribou are relatively flexible in their needs and can accommodate some man-imposed changes in their environment. This does not mean that there are no impacts on caribou associated with development projects but it implies that disaster scenarios are not realistic assumptions either.

Project surveillance was a very positive experience at Upper Salmon. This program contributed significantly to environmental protection, not necessarily by the magnitude of decisions made in the field but by the frequency of decisions. A surveillance officer can be expected to make ten or twenty recommendations in a day on a wide range of issues. This constant vigilance on many smaller points is critical in order to ensure that policies and guidelines are implemented during construction.

The Upper Salmon Development EIA is an example of how a prolonged and iterative decision-making pattern does not necessarily reduce environmental protection. In fact, a cooperative effort between proponents of large projects and the regulatory agencies can provide better environmental protection and ensure that the limited time and money spent on environmental protection is directed to where it can do the most good. During the upcoming period of EIA evolution, re-examination of decision-making patterns is encouraged in order to develop functional and equitable EIA processes.

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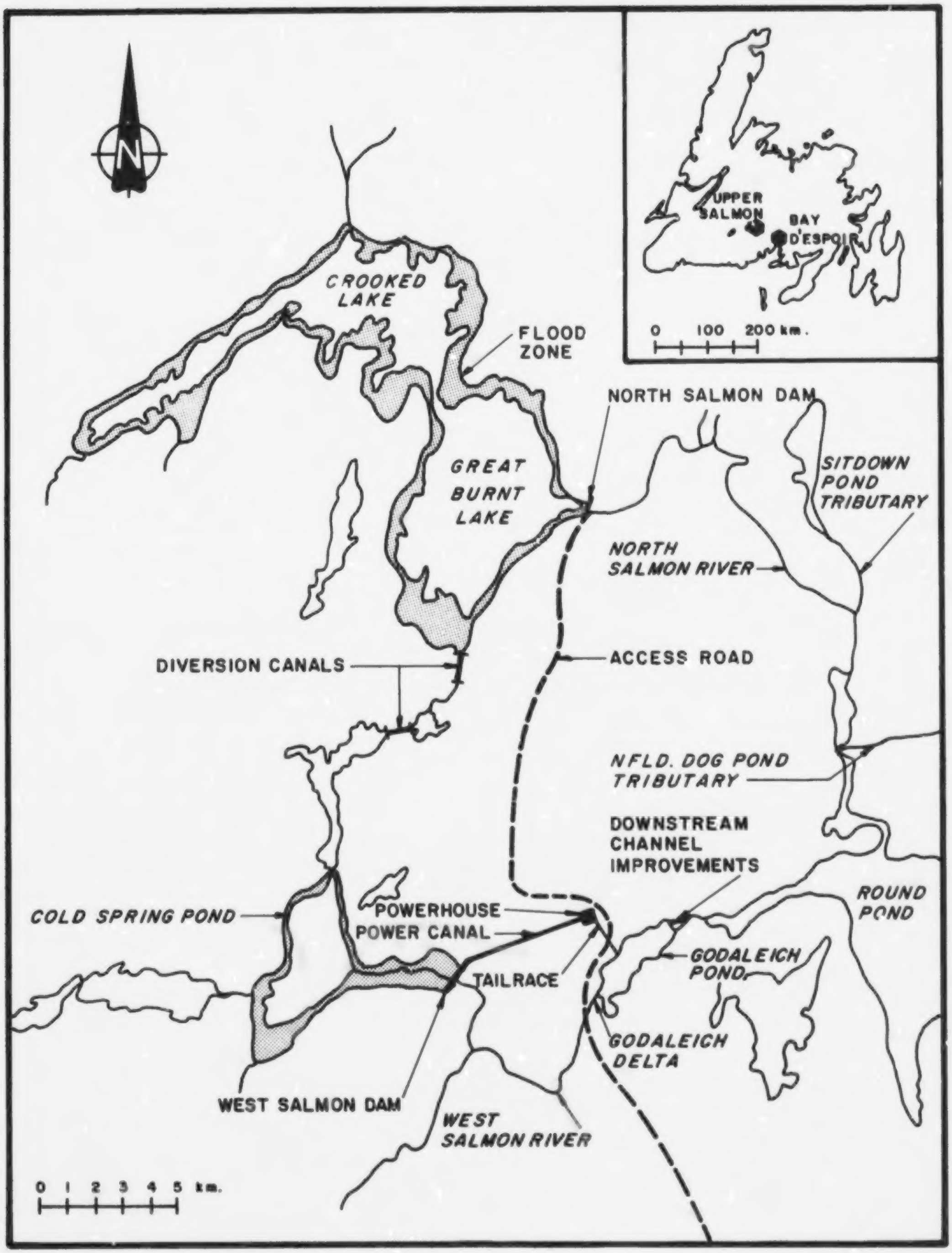
N
UPPER
SALMON
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0 100 200 km.
CROOKED
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BURNT
LAKE
SITDOWN
POND
TRIBUTARY
NORTH
SALMON RIVER
DIVERSION CANALS
ACCESS ROAD
NFLD. DOG POND
TRIBUTARY
DOWNSTREAM
CHANNEL
IMPROVEMENTS
ROUND
POND
COLD SPRING POND
POWERHOUSE
POWER CANAL
TAILRACE
GODALEICH
POND
GODALEICH
DELTA
WEST SALMON DAM
WEST
SALMON RIVER
0 1 2 3 4 5 km.

FIG. I. THE UPPER SALMON HYDROELECTRICAL DEVELOPMENT

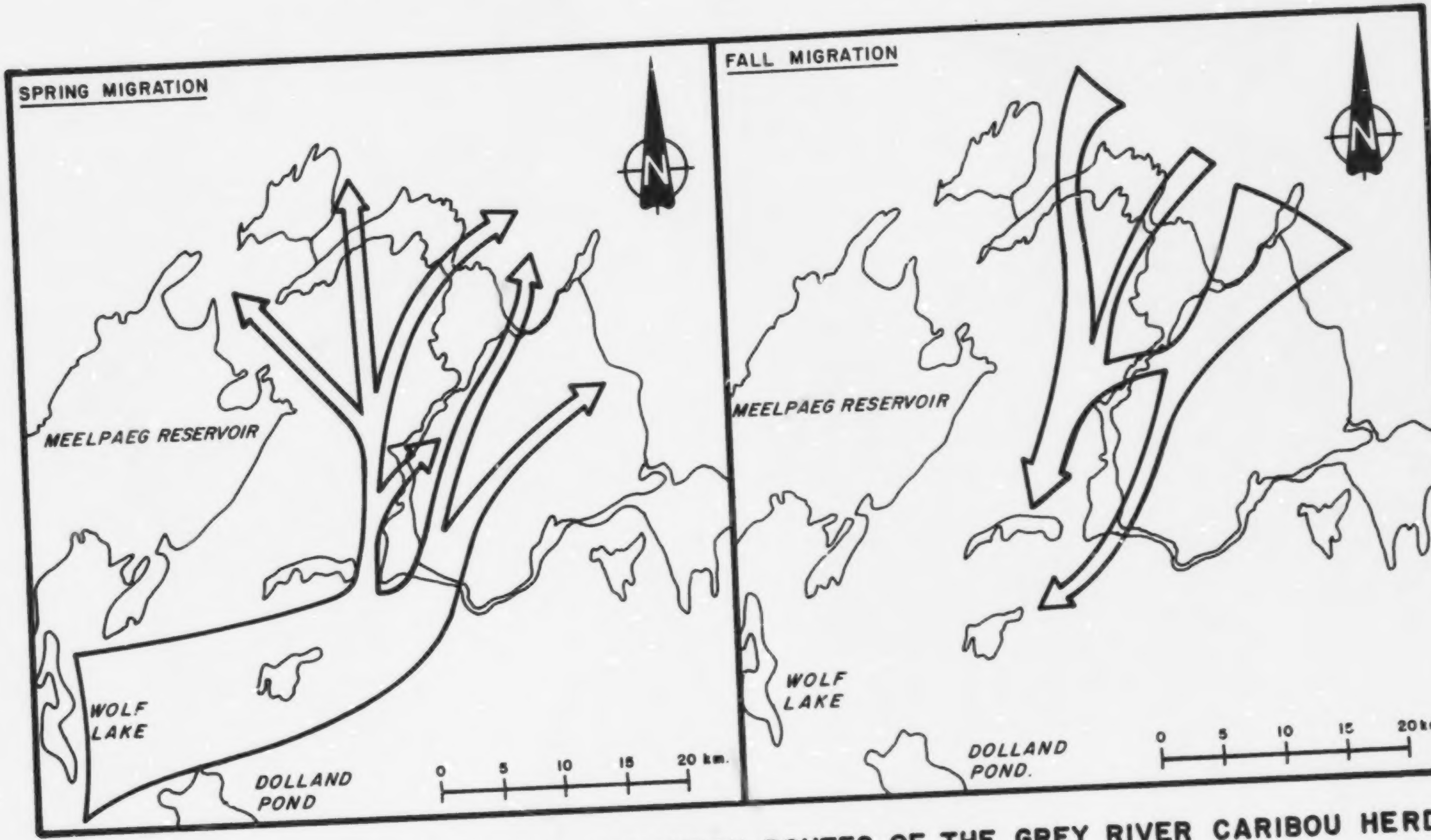
SPRING MIGRATION
MEELPAEG RESERVOIR
WOLF LAKE
DOLLAND POND
0 5 10 15 20 km.
N
FALL MIGRATION
MEELPAEG RESERVOIR
WOLF LAKE
DOLLAND POND.
0 5 10 15 20 km.
N

FIG. 2. GENERAL SPRING & FALL MIGRATION ROUTES OF THE GREY RIVER CARIBOU HERD THROUGH PROJECT AREA

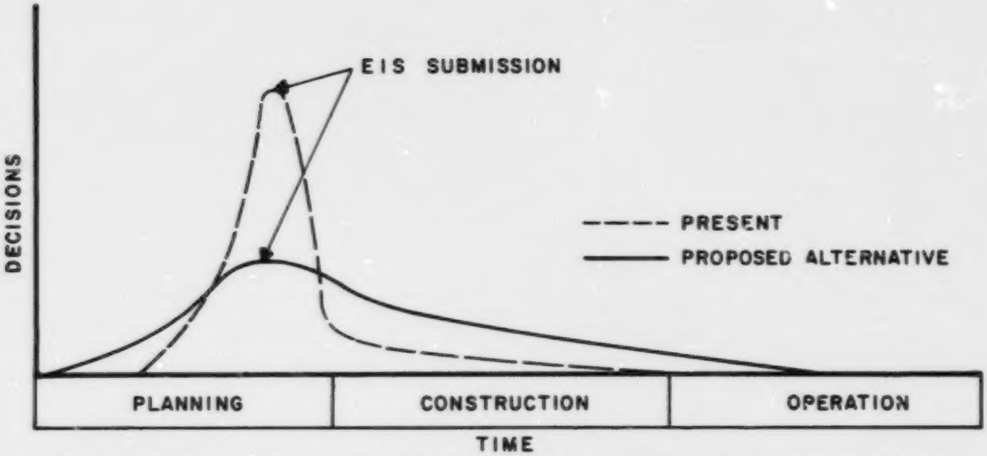

FIG. 3. PATTERNS OF ENVIRONMENTAL DECISION MAKING DURING AN IMPACT ASSESSMENT

A METHODOLOGY FOR SELECTING LOW-LEVEL RADIOACTIVE WASTE DISPOSAL SITES WITH APPLICATION TO THE OAK RIDGE RESERVATION

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ABSTRACT

A methodology was developed to select an environmentally acceptable site for low-level radioactive waste disposal for a predetermined region of interest using prescribed site suitability requirements. The methodology provides a defensible means for identifying candidate areas within the region, candidate sites within the areas, and an environmentally preferred site from the candidate sites. This is accomplished in site screening and site characterization stages. The site screening stage relies on reconnaissance data to identify a preferred site. The site characterization stage relies on a detailed site investigation to determine site acceptability. The methodology was applied to the U.S. Department of Energy Oak Ridge Reservation through the site screening stage.

INTRODUCTION

The disposal of low-level radioactive wastes in a safe and environmentally acceptable manner is an issue of international concern. In the United States, the current practice is by disposal in shallow land burial facilities. Recent legislation mandates that each state assume responsibility for the disposal of low-level radioactive wastes generated within the state.[1] This is expected to result in the development of additional disposal facilities.

The sites selected for new shallow land burial facilities will be subject to public review which necessitates the application of a defensible methodology for site selection. The site selection methodology must identify sites in a region that are capable of satisfying regulatory requirements and can withstand the scrutiny of licensing proceedings and public review. Acceptable sites must satisfy the applicable regulatory site selection criteria and technical requirements for shallow land burial facilities; remain a suitable choice after considering viable alternative sites; and be suited to the needs of the prospective developer. The method used for site selection should be clear, the bases for identifying potential sites should be stated, and the judgments which lead to the selection of the site should be apparent.

Site selection methodologies are commonly used to site major facilities.[2,3] Generally, a region of interest is identified, critical features for site acceptability are developed using site selection criteria, data are collected, a sensitivity analysis is performed, and sites are evaluated. Most site screening methodologies are qualitative because reconnaissance-level data are typically variable in coverage for the different sites being considered. The evaluation of candidate sites is a comparison of site characteristics in either qualitative or quantitative terms. Although characteristics may be weighted and ranked quantitatively, the associated assumptions or judgments do not necessarily render these evaluation methods more objective or valid than qualitative site comparisons.

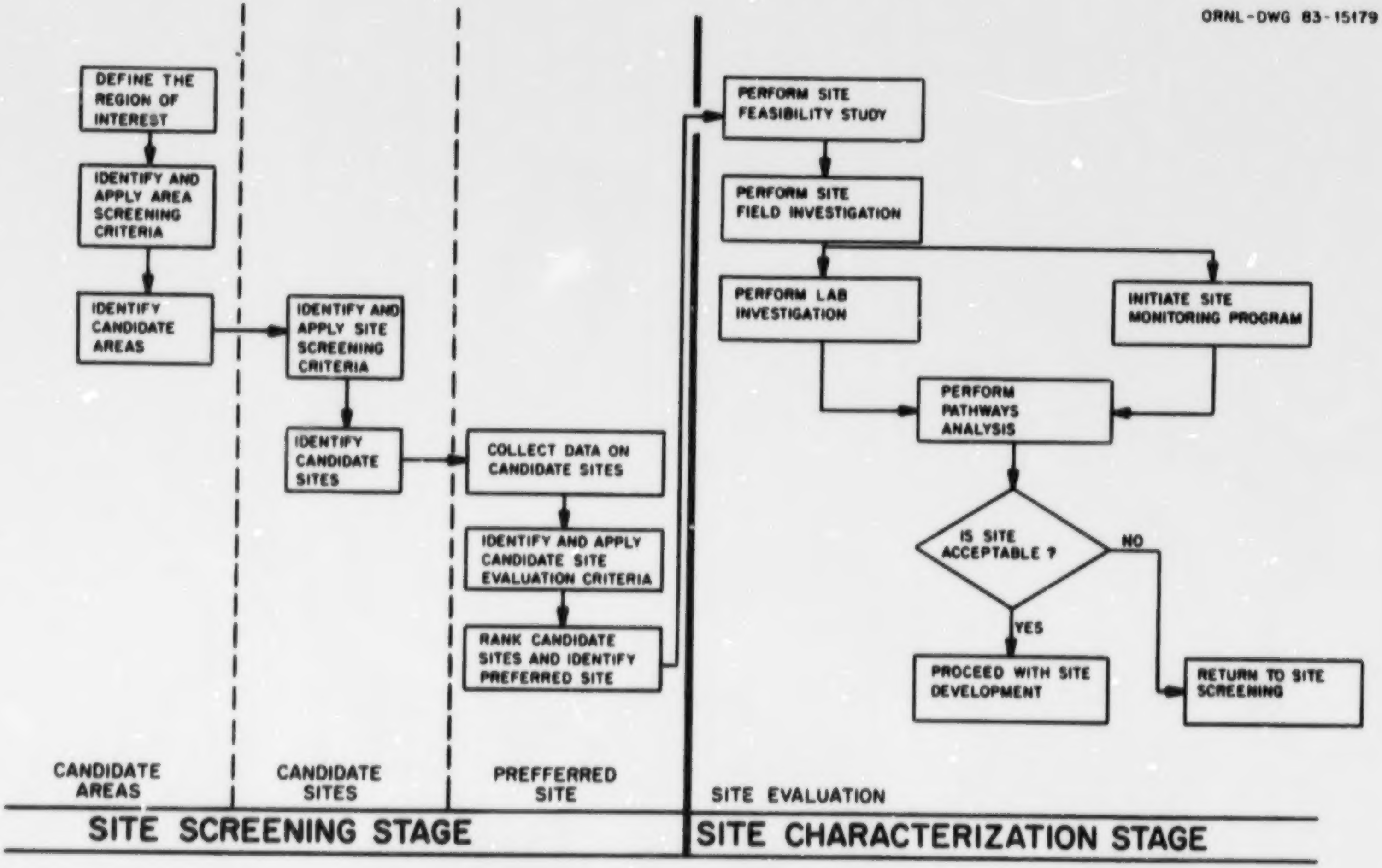
The selection of shallow land burial sites in the past was not performed with use of a consistent set of criteria or guidelines. Lacking regulatory guidance for site acceptability, the most prominent characteristics shared between the sites that were selected were the availability of land on or near a nuclear facility and government ownership of the land.[4] As a result, performance-based site selection methodologies have not been developed and applied to existing disposal facilities. Processes for selecting shallow land burial sites have been developed, although they have not been developed to the extent that they could be easily applied to identify a specific site. Lacking an available and demonstrated methodology to select a site, a methodology was developed that addresses the use of site selection criteria, the needs of the developer, and the consideration of alternative sites. The methodology was applied to the U.S. Department of Energy Oak Ridge Reservation.

SITE SELECTION METHODOLOGY

Site selection encompasses the screening of potentially viable sites within a region for a preferred site and the characterization of the preferred site for evaluation of site acceptability. Site screening is an inherently qualitative process that requires the comparison of several site factors of varying importance to identify a preferred site. Site characterization evaluates in depth the suitability of the preferred site for low-level waste disposal based on conformance with the site selection criteria. The site selection criteria used for this study are presented in Table 1. A summary of the methodology is illustrated in Figure 1.

Site Screening Stage

The objective of the site screening stage is to identify a preferred site for detailed characterization, performance analysis, and evaluation. Site screening encompasses definition of candidate areas, identification of candidate sites and identification of a preferred site. Site screening is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DEFINE THE REGION OF INTEREST
IDENTIFY AND APPLY AREA SCREENING CRITERIA
IDENTIFY CANDIDATE AREAS
IDENTIFY AND APPLY SITE SCREENING CRITERIA
IDENTIFY CANDIDATE SITES
COLLECT DATA ON CANDIDATE SITES
IDENTIFY AND APPLY CANDIDATE SITE EVALUATION CRITERIA
RANK CANDIDATE SITES AND IDENTIFY PREFERRED SITE
PERFORM SITE FEASIBILITY STUDY
PERFORM SITE FIELD INVESTIGATION
PERFORM LAB INVESTIGATION
INITIATE SITE MONITORING PROGRAM
PERFORM PATHWAYS ANALYSIS
IS SITE ACCEPTABLE ?
YES
NO
PROCEED WITH SITE DEVELOPMENT
RETURN TO SITE SCREENING
CANDIDATE AREAS
CANDIDATE SITES
PREFFERRED SITE
SITE EVALUATION
SITE SCREENING STAGE
SITE CHARACTERIZATION STAGE

Fig. 1. Summary of site selection methodology

performed using existing data and information sources and site reconnaissance. Site reconnaissance does not include detailed field studies but provides for field inspection of the existing environmental conditions. The methodology used in this study for site screening addresses the objectives of site screening and the goals of site selection by identifying candidate areas within a predefined region of interest, identifying a slate of candidate sites within the candidate areas and identifying a preferred site from the slate of candidate sites (Fig. 1).[5] Each step in the process uses progressively more restrictive criteria based on the developer's needs and the site selection criteria (Table 1).

Table 1. Site selection criteria

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1. New sites shall be of sufficient size to include a waste disposal area, administrative area, and adequate buffer zone to allow unrestricted human use beyond the site boundary.

2. New sites shall be located so that wastes can be buried either completely above or completely below the transition zone between the unsaturated and saturated zones.

3. New sites shall be located where flooding, wind and water erosion, and geologic hazards such as earthquakes, volcanoes, and slides and mud flows do not jeopardize performance.

4. New sites shall be located where hydrogeologic conditions allow subsurface migration of radioactivity to be reliably predicted.

5. Buffer zones for new sites shall be designed in consideration of hydrogeologic characteristics so that radioactivity releases comply with the objective of this order.

6. New sites shall be selected with consideration given to current and projected population distributions, land use, and resource development; accessibility of all-weather highways, rail routes, and utilities; and the location of waste generators.

7. New sites shall be selected in compliance with applicable federal, state, and local laws and regulations.

Source: U.S. Department of Energy, DOE Manual, Chap. 5820 (Draft), September 10, 1982.

The region of interest is predefined on the basis of need for additional low-level waste disposal facilities to service waste generators. The region may be a compact of states, a state, a DOE reservation, or some other geographical unit. The region should be large enough in size to include several candidate areas with at least one candidate site in each area for a reasonable comparison of candidate sites.

Candidate areas are identified by applying area screening requirements. These are exclusionary requirements that eliminate areas having features that preclude them from further consideration. These requirements are based on the essential needs for facility development (e.g., sufficient land area) and the site selection criteria that can be applied to an area. These requirements are used to identify areas within the region of interest having the fewest obvious deficiencies that would inhibit site development. The goal of area screening is to select enough candidate areas for identifying a sufficient number of candidate sites that will allow a valid site comparison incorporating regional variability.

Candidate sites are identified by applying site screening requirements. Site screening requirements include requirements that must be met for a site to be suitable for shallow land burial, that will be referred to as exclusionary requirements, and features that are desirable for a site. The exclusionary requirements are site-specific factors developed from the site selection criteria which must be satisfied for the site to be suitable for low-level waste disposal (e.g., gentle slope, absence of wetlands). Desirable features to be included in the site screening requirements could include facility needs (e.g., proximity to utilities) or other site conditions derived from the site selection criteria. Site screening requirements are used to identify a reasonable number of sites within the candidate areas that have the greatest potential as waste disposal sites and represent the regional variability within the candidate areas.

The ranking of candidate sites is performed after reviewing all available information on the candidate sites, a field inspection of existing environmental conditions and developing site selection parameters. Site selection parameters are derived from the site selection criteria. They are reflective of the significant regional characteristics to be examined in identifying a preferred site. The significance of each site selection parameter is based on available data and subjective evaluation. This step is critical to the ultimate results since the selection of parameters and assignment of relative significance influence which site is designated as the preferred site.

The preferred site is selected from the candidate sites using a comparative matrix for each site selection parameter. A single parameter is selected and the comparative superiority or inferiority of one site to another relative to the parameter is determined. The sites are then ranked from highest to lowest for each parameter. The composite of site rankings and significance for all parameters is examined to identify a preferred site. This last step in the site screening analysis is subjective and may not result in a single obviously superior site. Site ranking may yield two or three sites that, based upon available information, are essentially equivalent and superior to all other sites. In such cases, the preferred site may be determined by the interests of the developer rather than by the slight superiority established by the ranking exercise. The objective of this process is not necessarily to identify the best site because the available information limits the capability of making such a determination. Instead, the preferred site should be the site which is best suited to the needs of the developer and which can satisfy the site selection criteria.

Site Characterization Stage

The site characterization stage evaluates in depth the suitability of the preferred site for waste disposal based on conformance with the site selection criteria. Characterization includes a preliminary investigation of the feasibility of site development, a comprehensive field study, a laboratory analysis of field samples, a site monitoring program and a pathways analysis. The methods employed at this stage are considerably more costly and time consuming than site screening.[6] Characterization provides the site-specific data needed for verifying the compliance of the site with the site-selection criteria and for establishing the requirements for site design and utilization.

The site feasibility investigation provides a preliminary concept of site utilization and performance and initiates the interaction of site design with the field investigation, laboratory studies, pathways analysis, and environmental monitoring activities. The site feasibility study includes characterization of the radioactive waste, a conceptual design, a preliminary site utilization plan, and a preliminary analysis of site performance. The site feasibility investigation can result in a field investigation that is cost-effective, a pathways analysis that is more representative of facility operation and environmental data more useful for analysis and design.

The field investigation provides the necessary site-specific data for the evaluation of site performance and for further site development. The field investigation is comprehensive and requires the utilization of technical specialists and specialized equipment. Geological and hydrological investigations of site conditions are the primary focus of the field program. Additional areas of investigation may be significant depending on site-specific conditions and on the results of the site feasibility investigation.

Laboratory analysis of field samples and a monitoring program are included to supplement the data base developed during the field study. The hydrological aspects of the monitoring program are especially important for establishing the data base for pathways analysis and site design.

The pathways analysis determines if the preferred site can satisfy the site selection criteria. The potential pathways for consideration include groundwater transport, intrusion, surface water transport, and atmospheric transport. The pathways analysis considers conservative scenarios of site operations and closure for investigation of the fate of potential releases of radioactivity to the environment. The effects of engineered design features proposed for the site are factored into the analysis as are the site-specific data collected during the field and laboratory investigations. If the pathways analysis results indicate that the site is unacceptable for low-level waste disposal, then additional design features, limitations on site utilization, or alternative sites need to be considered (Fig. 1). If the pathways analysis results indicate that the site is acceptable, the site selection process is completed and site development proceeds to detailed design.

APPLICATION TO OAK RIDGE RESERVATION

The application of the site selection methodology was performed with DOE as the developer and the region of interest defined as the Oak Ridge Reservation. The limited size of the Oak Ridge Reservation as a region of interest narrowed the geologic and hydrologic environments from which a site could be selected. The effect of the restricted region of interest is evident in the application of the criteria.

Candidate Area Identification

The candidate area screening requirements and the associated site selection criteria for application to the Oak Ridge Reservation (ORR) are presented in Table 2. The ORR is located in the valley and ridge province and includes four major geologic units (Knox Group, Conasauga Group, Chickamauga Group, Rome Formation). Local and regional data for the geologic formations that outcrop on the ORR were used for identification of areas with adequate soil thickness. Terrains underlain by units of the Conasauga and Knox Groups are more likely to have soil thicknesses exceeding 10 m than are terrains underlain by the Rome Formation and the Chickamauga Group. These latter geologic units were excluded from further consideration as was land area in the 100-year floodplain, land area with the presence of wetlands, and land area previously used for burial of waste. Areas with potentially adequate unsaturated zone thickness were estimated by excluding all areas with less than 7 m of elevation above existing surface water bodies. The candidate areas identified are shown in Fig. 2.

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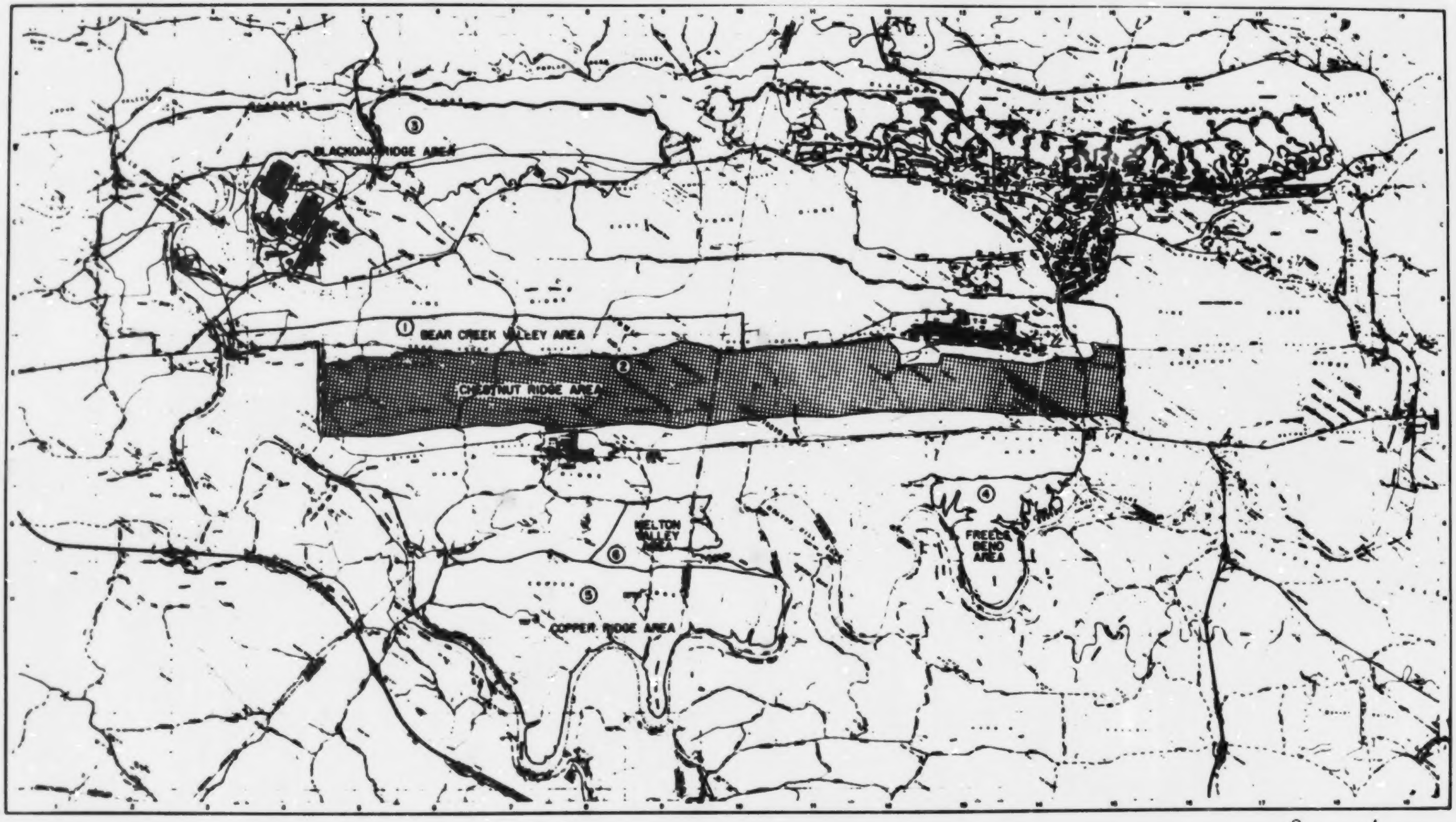
③
BLACKOAK RIDGE AREA
① BEAR CREEK VALLEY AREA
②
CHESTNUT RIDGE AREA
④
FREELS BEND AREA
MELTON VALLEY AREA
⑥
⑤
COPPER RIDGE AREA
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Fig. 2. Candidate areas on the Oak Ridge Reservation

Table 2. Candidate area screening requirements for the Oak Ridge Reservation

Requirement	Related site selection criteria[a]
1. Area should be outside the 100-year floodplain and wetlands.	3
2. Estimated soil thickness should exceed 10 m (30 ft).	5
3. Estimated unsaturated zone thickness should exceed 7 m (20 ft).	2
4. Area should be large enough to include at least 1 site with active land area exceeding 80 ha (200 acres).	1,5
5. Area should be defined exclusive of previously utilized land for the burial of waste.	6

[a] Numbers indicate the criteria presented in Table 1.

Candidate Site Identification

The candidate site screening requirements for application to the candidate areas are presented in Table 3. Tracts of land within the security boundary and with less than 25% slope were identified using a topographic map. Karst features, which are commonly observed as closed topographic depressions, are prevalent in Knox Group areas and were identified by field inspection along with areas of residential development. On the basis of excessive slope, karst, and close proximity to residential development the Freels Bend, Copper Ridge, and Blackoak Ridge areas were eliminated from further consideration (Fig. 2). The Melton Valley area was excluded from further consideration because insufficient land area was available for waste disposal. The remaining areas, Chestnut Ridge and Bear Creek Valley, included seven candidate sites as shown in Fig. 3. These sites included both geologic units suitable for disposal (Knox Group, Conasauga Group) and the variability of terrestrial and hydrologic environments within the ORR.

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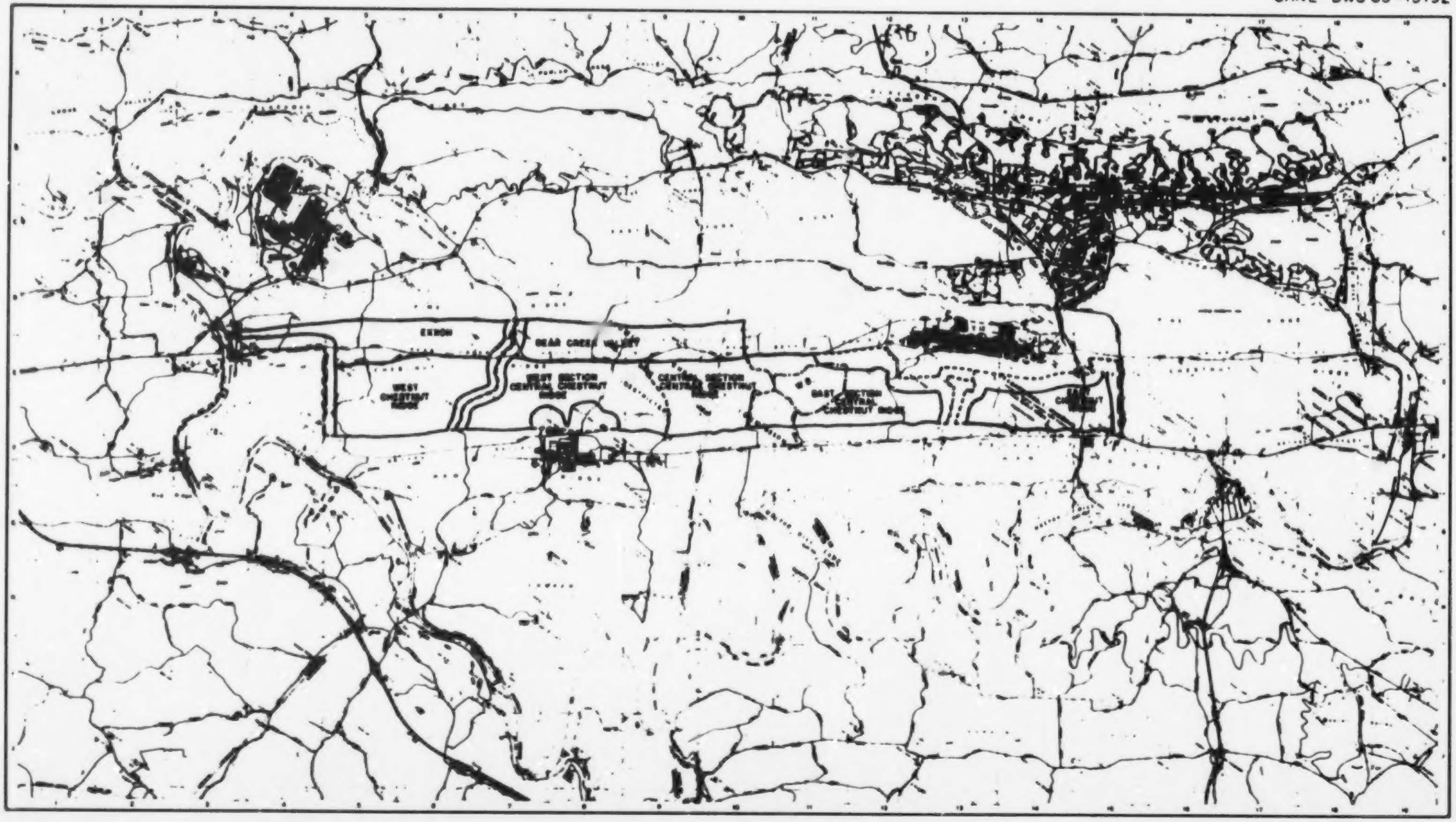
EXXON
BEAR CREEK VALLEY
WEST CHESTNUT RIDGE
WEST SECTION CENTRAL CHESTNUT RIDGE
CENTRAL SECTION CENTRAL CHESTNUT RIDGE
EAST SECTION CENTRAL CHESTNUT RIDGE
EAST CHESTNUT RIDGE
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OAK RIDGE AREA

Fig. 3. Candidate sites on the Oak Ridge Reservation

Table 3. Candidate site screening requirements for the Oak Ridge Reservation

Requirements	Related site selection criteria[a]
Exclusionary requirements:[b]	
1. Exclude areas with evidence of karst topography	3
2. Exclude areas with slope greater than 25%	6,3
3. Exclude areas that do not fall within a security boundary defined as: 250 m from existing plants 250 m from public roads 250 m from reservation boundary	
4. Exclude areas adjacent to residential development	6
Desirable features:	
1. Available area greater than 80 ha (200 acres)	1,5
2. Slope less than 10%	6,3
3. Easy access to site by road	6
4. Site in close proximity to waste generators	6
5. Utilities available for site development	6

[a] Numbers indicate the criteria presented in Table 1.

[b] Exclusionary requirements refer to site conditions which, if present, would render the site unsuitable for shallow land burial.

Preferred Site Identification

The parameters of interest for preferred site identification derived from the site selection criteria are presented in Table 4. Also shown is the significance of each parameter as determined from site reconnaissance and review of available information. The candidate sites were pairwise compared as better, the same, or worse with respect to each other for these parameters. The three sections of the Central Chestnut Ridge site were treated separately with the understanding that they could be recombined to form a consolidated site later in the analysis.

Table 4. Site selection parameters for identification of the preferred site

Site Selection Parameter	Associated Site Selection Criteria (Table 1)
1. Land Use - Medium Significance Preferred site should o maximize land area o minimize alernative uses	1,6,7
2. Hydrology - High Significance Preferred site should o minimize surface water interactions with site o minimize groundwater interactions with site o maximize predictability and monitorability	2,3,4,5,7
3. Geology - High Significance Preferred site should o avoid geologic hazards o minimize slope o minimize site complexity	3,4,5
4. Soils - Medium Significance Preferred site should o maximize soil thickness and stability o minimize erosion	2,4,5
5. Socioeconomics - Low Significance Preferred site should o minimize offsite impacts o maximize ease of site access and utilities	6,7
6. Ecology/Meteorology - Low Significance Preferred site should o avoid important habitats	7

Table 5 presents the comparison of the sites with respect to their hydrologic characteristics. These include surface water, groundwater, water quality, and hydrogeologic predictability. The Conasauga Group sites (Bear Creek site, Exxon site) were comparatively worse than the Knox Group sites (West Chestnut Ridge, Central Chestnut Ridge, East Chestnut Ridge) because of comparatively shallow groundwater. Surface water outlets and site interfaces with surface water are more common in the Conasauga Group sites than

Table 5. Comparison of sites - hydrology
Significance: High

Site	Comparison sites						
				Central Chestnut Ridge			
	Exxon	Bear Creek Valley	West Chestnut Ridge	West section	Central section	East section	East Chestnut Ridge
Exxon	▥[a]	0	-	-	-	-	-
Bear Creek Valley	0	▥	-	-	-	-	-
West Chestnut Ridge	+	+	▥	-	-	0	-
West section	+	+	+	▥	+	+	-
Central section	+	+	+	-	▥	+	-
East section	+	+	0	-	-	▥	-
East Chestnut Ridge	+	+	+	+	+	+	▥

[a] ▥ = same site; + = better than, such as the presence of fewer streams; - = worse than, such as a shallower depth to the water table; 0 = no difference.

Table 6. Ranking of sites for site selection parameters

Parameter	Hydrology	Geology	Soil	Land use	Socio-economic	Ecology/ meteorology
Significance:	High	High	Medium	Medium	Low	Low
Highest rank	East Chest. Ridge	Exxon	Cent. Chest. Ridge-Cent.	Bear Creek Valley	Exxon	Exxon
	Cent. Chest. Ridge-West	Bear Creek Valley	West Chest. Ridge	Cent. Chest. Ridge-Cent.	Bear Creek Valley	East Chest. Ridge
	Cent. Chest. Ridge-Cent.	Cent. Chest. Ridge-Cent.	East Chest. Ridge	West Chest. Ridge	Cent. Chest. Ridge-Cent.	Cent. Chest. Ridge-West
	West Chest. Ridge	West Chest. Ridge	Cent. Chest. Ridge-East	East Chest. Ridge	Cent. Chest. Ridge-East	Bear Creek Valley
	Cent. Chest. Ridge-East	East Chest. Ridge	Cent. Chest. Ridge-West	Exxon	East Chest. Ridge	Cent. Chest. Ridge-Cent.
	Exxon	Cent. Chest. Ridge-East	Exxon	Cent. Chest. Ridge-West	West Chest. Ridge	Cent. Chest. Ridge-East
Lowest rank	Bear Creek Valley	Cent. Chest. Ridge-West	Bear Creek Valley	Cent. Chest. Ridge-East	Cent. Chest. Ridge-West	West Chest. Ridge

[ ] = roughly equivalent.

in the Knox Group sites. The Conasauga and Knox Groups' geohydrology is difficult to model. Flow in the Conasauga Group is fracture dominated, and flow in the Knox Group is dominated by solution cavities. The West Section of Central Chestnut Ridge and East Chestnut Ridge were noted to be the most attractive because of their comparative lack of springs and surface water. The other Knox Group sites were considered less attractive because of the abundance of springs and surface water outlets. East Chestnut Ridge was considered the most attractive site because of the ease in monitoring site runoff and the land is presently pasture with hydrological behavior similar to that expected after facility development.

Similar comparisons were performed for each of the other parameters identified in Table 4. The results of the comparative ranking were assembled and are presented in Table 6. Sites that were comparatively better than the other sites were ranked highest with equivalent rankings given to sites with similar characteristics. Several sites had equivalent rankings for several parameters which was expected because of the many similar features of the candidate sites. The rankings of the sites were dramatically different for hydrology and geology, the two parameters of high concern.

The parametric rankings were interpreted to provide an overall ranking of the candidate sites as shown in Table 7. The results are not definitive

Table 7. Summary of results - overall ranking

	Conasauga Group sites	Knox Group sites
Highest rank	Bear Creek Valley	[Central Chestnut Ridge-Central Section
	Exxon	East Chestnut Ridge
		West Chestnut Ridge
		Central Chestnut Ridge-West Section]
Lowest rank		Central Chestnut Ridge-East Section

[ ] = roughly equivalent

for most of the sites. The ranking of the Conasauga Group sites over the Knox Group sites is dependent on the relative importance assigned to hydrologic and geologic characteristics. Debate surrounding this important point is longstanding and ongoing. Naturally, the methodology cannot be expected to resolve such a technical issue; however, the viability of the procedure is enhanced because the basis for debate is clearly illustrated. Further development of data would be necessary to establish which of the four Knox Group sites is more advantageous. These results suggest that both the Knox and Conasauga Group sites have deficiencies for low-level waste disposal that must be addressed in the design of a disposal facility.

The results of this application do not identify a clearly environmentally superior site. In such cases, the preferred site is best determined by other factors rather than by attempting to force a definitive conclusion from those factors considered. Other factors may include prior experience in operating shallow land burial facilities, costs of site development, and detailed facility needs. Use of either the Conasauga or Knox Group for future disposal will depend on the results of the ongoing technical studies and disposal requirements.

CONCLUSIONS

Site selection criteria provide minimum technical guidelines to be met in low-level waste site selection. A methodology for use of the site selection criteria is necessary for their effective application in site selection. The methodology used for this study requires the development of regionally-specific screening requirements to utilize the site selection criteria in the identification of candidate areas, candidate sites, and a preferred site.

The site selection criteria were made functional through the use of screening requirements, site selection parameters and the development of the regional significance of each site selection parameter. These functional forms of the criteria need to be reconsidered for each site selection study. As functional forms of the site selection criteria, they are the dominant influence in identifying a preferred site.

The candidate area identification utilizes somewhat arbitrary, exclusionary requirements for focusing the site screening process. The experience in applying these requirements suggests that they should be formulated with as great an emphasis as possible on the desirable physical features for the site. For most waste disposal applications the physical features of significance are geologic and hydrologic. Placing early emphasis on institutional requirements for candidate area identification can result in the identification of candidate areas that are undesirable from a geologic and hydrologic perspective. Institutional requirements are subject to frequent changes in policy, but little can be done to significantly alter the geologic or hydrologic setting that will result in stable conditions for waste disposal.

Candidate site requirements should be formulated to include site-specific, exclusionary requirements that cannot be specified for area screening. The desirable features for candidate site screening should be selected so that the slate of candidate sites is sufficiently large for comparison but not so lengthy as to inhibit comparative analysis. Institutional requirements should be incorporated into the candidate site screening requirements.

The identification of a preferred site results from a comparison of the slate of candidate sites with regard to the prepared list of site selection parameters. The site selection parameters need to be based on the site selection criteria and the regionally relevant factors influencing site performance and acceptability. The assignment of significance to each parameter and the parameters themselves largely influences the identification of a candidate site as the preferred site.

The characterization of a preferred site is expensive and time consuming. Adaptation of this methodology for other site selection investigations should be considered and is recommended for sites that are not easily characterized. The recommended process in the methodology is to encourage early interaction among the field investigation program, pathways analysis, and site design. The site feasibility investigation is intended to facilitate integration of these activities. By encouraging interaction of the field activities with the pathways analysis and site design, costs, delays in licensing, and delays in site development can be reduced. For sites that are especially difficult to characterize, several phases of site characterization may be appropriate to ensure site acceptability and effective site utilization.

Application of the site selection criteria using the methodology was qualitative and required considerable judgment at each step. The screening requirements for identifying candidate areas and candidate sites were somewhat arbitrary. They included the site selection criteria along with other requirements reflecting the need to consider alternative sites and the needs of the developer.

The definition of the region of interest was the most exclusionary step in the application of the site selection criteria. The definition of the Oak Ridge Reservation as the region of interest admitted only two viable geologic groups for consideration. Neither of these groups is an ideal geologic or hydrologic setting for low-level waste disposal. The site selection criteria were applied in this context. As a result of the limited region of interest, the preferred sites that were identified may not satisfy all of the technical requirements in the site selection criteria without the incorporation of engineered design features or improved waste forms. The site selection criteria, however, do identify those deficiencies which require further consideration in the design of a facility at a preferred site.

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ENVIRONMENTAL PROTECTION BEYOND FACILITY LOCATION

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ABSTRACT

This paper examines the issue of environmental protection after the site or route for an energy facility has been chosen. Key environmental protection activities include: detailed environmental protection planning and facility location; incorporation of environmental protection measures into contractual documents; environmental education of construction personnel; environmental inspection, surveillance and monitoring of construction; and as-built environmental evaluation. The paper concludes by stating that unless these environmental protection activities take place, the original facility location efforts can be wasted.

INTRODUCTION

The past fifteen years in Canada have witnessed a heightened sensitivity towards the impacts of man's actions on the natural and social environment. Selecting locations for energy facilities has been no exception, whether the exercise be to site a hydro-electric generating station or to route a natural gas pipeline. A great deal of time and money is spent studying the project environment, assessing impacts, evaluating alternatives and recommending the most environmentally appropriate facility location complete with guidelines intended to mitigate impacts. Voluminous documents are compiled for the satisfaction of regulatory agencies who approve the project subject to terms and conditions. With all this attention, one might assume that environmental protection is virtually guaranteed. Unfortunately, this is not the case.

Environmental impact assessment (EIA) has focused environmental planners' efforts on processing papers so that they perceive their job being completed once regulatory approval is received (Fairfax, 1978). Job performance is measured in terms of ease of project approval rather than ultimate environmental protection and EIA Reports judged more by weight than by content. With the necessary approvals in hand, environmental planners pass the project back to the engineers and construction managers and then quietly bow out of the picture. Whereas six months earlier the environmental planner was fighting and winning victories for environmental protection on paper, these victories often turn out to be defeats on the ground when the facility is built. Streams get silted in or dried up, topsoil is destroyed, merchantable timber is burned, steep slopes are washed away, sensitive fish or wildlife populations are decimated by opportunistic fishing or hunting, and competing land users are inconvenienced. Many environmental planners are becoming increasingly cynical about environmental protection beyond facility location. Duncan (1976) accurately sums up the situation:

> "Environmental concerns are debated at universities, legislated by governments, reviewed in board rooms, documented by environmentalists and analyzed by engineers, but nothing constructive is accomplished until the man in the field becomes aware of the sensitive elements of the environment and acts accordingly. One positive element in the field accomplishes more than pages of print."

Real environmental protection demands that the same level of effort expended on facility location be extended throughout the construction and operation stages. Otherwise the original efforts are wasted. In those situations where the most environmentally appropriate location has not been selected for economic, engineering or political reasons, environmental protection during construction and operation becomes even more critical.

This paper examines the important issue of environmental protection after the site or route for an energy facility has been chosen. Key environmental protection activities are discussed within the context of an environmental management process. Implications for improving siting and routing efforts on subsequent projects are also explored.

ENVIRONMENTAL PROTECTION ACTIVITIES

Environmental Management Process

The environmental protection activities described in this paper are part of a larger environmental management process for projects. A generalized environmental management process is presented in Figure 1. In the context of Figure 1, environmental planners' efforts have traditionally

Stage of Project	Environmental Protection Activity	
A. Planning	1. Facility Location (site or route)	
	2. Environmental Impact Assessment and Mitigation	
	3. Regulatory Approval	
	4. Detailed Environmental Protection Plan	
	5. Detailed Facility Location	
	6. Contractual Documents	
	7. Environmental Education	
B. Construction	8. Environmental Inspection)	(Adjustments made to No. 4 if warranted)
	9. Environmental Surveillance)	
	10. Monitoring)	
	11. As-Built Environmental Evaluation	
C. Operation	12. Monitoring	
	13. Vegetation Management	
D. Abandonment	14. Reclamation	

Figure 1: ENVIRONMENTAL MANAGEMENT PROCESS FOR PROJECTS

faded after Activity No. 3. Recently, focus has begun to shift to Activity Nos. 4 to 14. The focus of this paper is on Activity Nos. 4 to 11.

Detailed Environmental Protection Plan (No. 4)

The general discussion on impact mitigation provided in most Environmental Impact Assessment Reports is satisfactory for regulatory approval but not for construction. There are two main reasons for this: First, the EIA is generalized and does not provide specific environmental protection instructions which can be easily followed in the field. Second, construction personnel are not inclined to wade through a telephone book-sized document in search of sections of concern to them. More often than not, the EIA ends up behind the seat of the pick-up or as a source of scratch paper for games of "X's and O's." Although Environmental Protection Plans (EPP's) sometimes suffer a similar fate, they have a better chance of getting their message across because they are much smaller than an EIA and written specifically for construction use in a language familiar to construction personnel.

The purpose of an EPP is to instruct construction personnel where a departure from standard construction practice is warranted in order to minimize adverse environmental impacts. These 'departures' are known as environmental protection measures. Impacts are minimized in two ways - first, by scheduling construction to avoid sensitive periods and second, by employing an alternate construction technique.

The simple case of a pipeline water crossing will serve to illustrate this point. Normal pipeline practice is to ditch through the watercourse and install the pipe while water is flowing across the work area. This wet crossing technique can cause heavy sediment loading which may be potentially harmful to fish and other aquatic organisms. If the watercourse supports significant populations of fall spawning fish species, scheduling construction to a period when the fish are less sensitive (such as late summer) will minimize impacts. If rescheduling is impossible for engineering, access or economic reasons, a more sensitive construction technique is warranted to minimize sediment loading. A dry crossing technique such as fluming is one example (see Mutrie and Scott, 1982, if interested in more information on pipeline water crossing techniques). Other examples of environmental protection measures include: constructing across farmlands after harvest; salvaging topsoil and merchantable timber; controlling drainage and erosion; and reclamation of disturbed areas, including revegetation within one growing season.

The Environmental Protection Plan identifies the placement of environmental protection measures on a Reference Map with additional description on each measure provided in the accompanying Report. In order to assist construction personnel to understand the environmental protection measures, the Plan should be detailed, site specific and written in construction style and language. Other recommended standards for Environmental Protection Plans are provided in Figures 2 and 3. For illustration purposes, an example of an Environmental Protection Plan Reference Map is provided in Figure 4.

A. Map Base and Size of Drawing

- The environmental protection measures appear on one map or series of maps.
- Size of drawing is convenient for field use. Folded A-1 size paper (594mm x 840mm) works well.
- If available, the construction plans are used as a base map. If not, an aerial photo mosaic is used. The mosaic is made up of the most recent photography taken without snow or cloud cover. Good contrast and resolution are desirable.
- If topography is a major factor in environmental protection, a profile is prepared. Erosion control measures, such as berms and cross ditches can be shown on the profile.

B. Scale - If construction plans are used, scale is not of concern. Otherwise, the scale should be sufficiently large to show the desired detail without an awkward number of drawings. A scale of 1:10,000 is typically used on pipelines. A two-scale system is also useful, i.e., full coverage at 1:20,000 or 1:50,000 and partial coverage of sensitive areas such as streams at 1:2,000 or 1:5,000.

C. Alternative Facility Locations - These are not shown as the Plan is specific to the selected facility location.

D. Environmental Description - Kept to an absolute minimum so as not to confuse construction personnel. The Plan is an "action" rather than a "descriptive" document.

E. Delineation of Work Area - The requirement for work area of the main facility and ancillary facilities (such as camps, access roads, powerlines) is shown. On linear facilities, the standard right-of-way width, width of additional disturbance and locations of extra width are identified.

F. Identification of Environmental Protection Measures - The placement of specific measures is clearly identified. Alternatives include slack chainage, kilometre posts, arrows, legal land descriptions and symbols.

G. Detail of Annotation - Restricted space on construction plans limits detail of annotation. One method is to briefly describe the environmental protection measure and then to refer the user to the appropriate section in the Report. A second method is to employ a coding system for each environmental or reclamation unit.

Figure 2: RECOMMENDED STANDARDS FOR ENVIRONMENTAL PROTECTION PLAN REFERENCE MAPS

A. Construction Schedule
- The timing and duration of each construction activity is presented, for example surveying, site preparation and clean-up.
- Target date for facility operation is provided.

B. Contingency Plans
- For: slippage in construction schedule; wet weather; insufficient frost depth or snowfall (winter job); accidental spills or releases of toxic substances; bedrock encounter requiring blasting; forest fire; and other potential emergencies.

C. Landowners, Government and Notification
- Landowner and government concerns are incorporated into the Plan. Both groups are kept informed during construction.

D. Environmental Protection Measures for:

a) Each Relevant Construction Activity: Survey, fences and gates, clearing, grading, excavation, installation, backfilling, drainage and erosion control, clean-up and reclamation.

or for:

b) Each Environmental or Reclamation Unit: Forested lands, cultivated and hay lands, irrigated lands, pasture lands, wetlands, erosion control units, water crossings, road and rail crossings, wildlife lands.

E. Annotated Drawings
- Typical and Special design drawings are prepared to illustrate details of environmental protection measures to be implemented at locations shown on Reference Map.

F. Inspection and Monitoring
- Plans for inspecting construction activities for compliance are made. The chain of command and responsibility is detailed. If required, plans for quantitative monitoring of environmental impacts are also made.

Figure 3: RECOMMENDED STANDARDS FOR ENVIRONMENTAL PROTECTION PLAN REPORTS

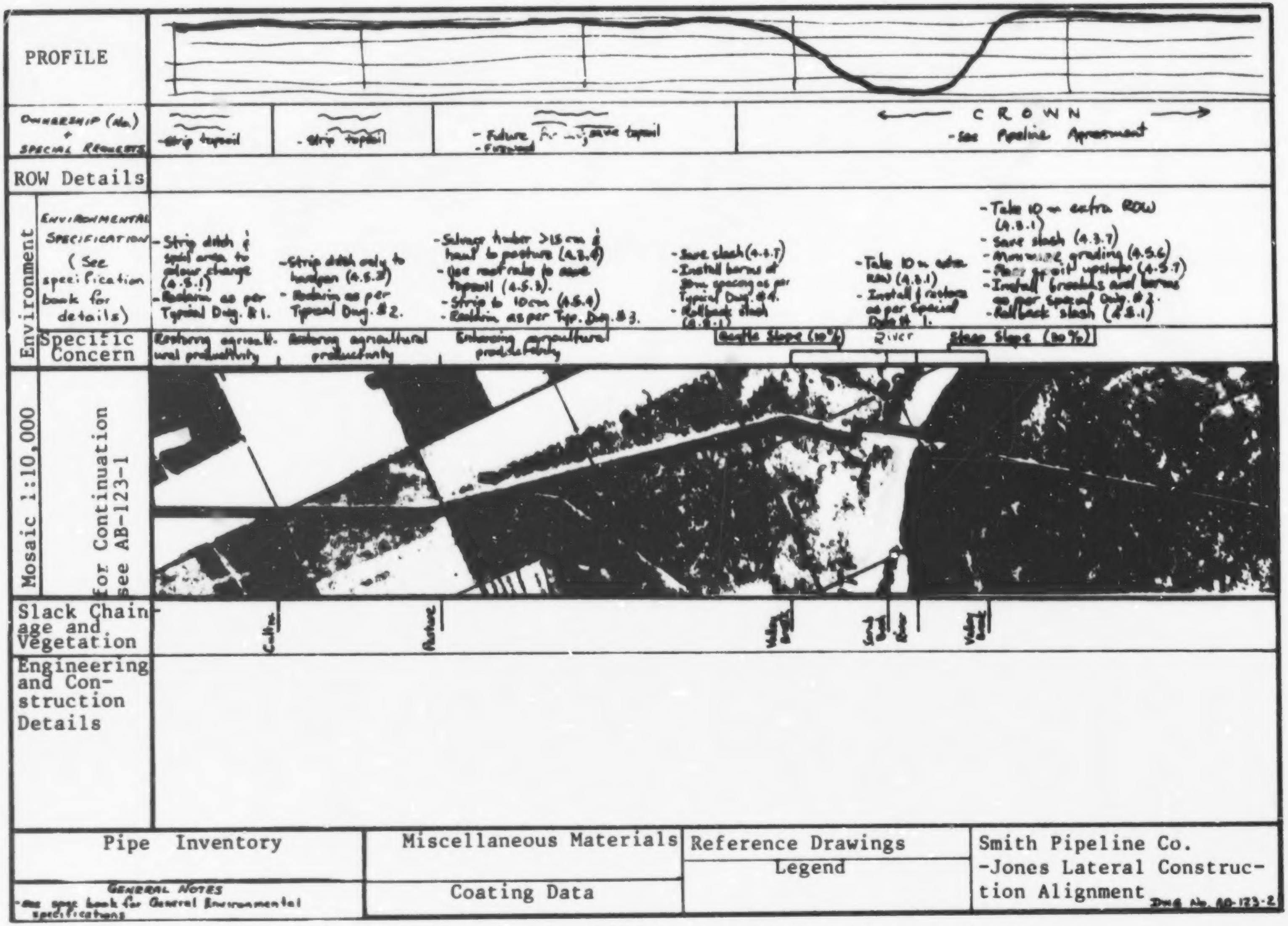
PROFILE
OWNERSHIP (No.) + SPECIAL REQUESTS
-Strip topsoil
- Strip topsoil
- Future for - - save topsoil
- Forested
CROWN
- See Pipeline Agreement
ROW Details
Environment
ENVIRONMENTAL SPECIFICATION (See specification book for details)
- Strip ditch & spoil area to colour change (4.5.1)
- Reclaim as per Typical Dwg. #1.
- Strip ditch only to hardpan (4.5.2)
- Reclaim as per Typical Dwg. #2.
- Salvage timber >15 cm & haul to pasture (4.3.4)
- Use root rake to save topsoil (4.5.3).
- Strip to 10 cm (4.5.4)
- Reclaim as per Typ. Dwg. #3.
- Save slash (4.3.7)
- Install berms at 30m spacing as per Typical Dwg. #4.
- Rollback slash (4.8.1)
- Take 10 m extra ROW (4.3.1)
- Install & restore as per Special Dwg. # 1.
- Take 10 m extra ROW (4.3.1)
- Save slash (4.3.7)
- Minimize grading (4.5.6)
- Place spoil upslope (4.5.7)
- Install breakers and berms as per Special Dwg. # 2.
- Rollback slash (4.8.1)
Specific Concern
Restoring agricultural productivity
Restoring agricultural productivity
Enhancing agricultural productivity
Gentle Slope (10%)
River
Steep Slope (30%)
Mosaic 1:10,000
For Continuation see AB-123-1
Slack Chainage and Vegetation
Cultiv.
Pasture
River
Engineering and Construction Details
Pipe Inventory
GENERAL NOTES
- see spec book for General Environmental specifications
Miscellaneous Materials
Coating Data
Reference Drawings
Legend
Smith Pipeline Co.
-Jones Lateral Construction Alignment
Dwg. No. AB-123-2

Figure 4: SAMPLE ENVIRONMENTAL PROTECTION PLAN REFERENCE MAP

Detailed Facility Location (No. 5)

Just because the location of a site or route is shown precisely on a mosaic does not necessarily mean it will be located there on the ground. Surveyors often make small mistakes which shift the facility location and create unanticipated problems. Or a surveyor from the old school, resentful of being replaced as a 'pathfinder' by environmentalists and engineers, may decide to do a little unofficial site or route selection of his own. To be fair though, surveyors are often working under difficult field conditions trying to follow uncontrolled air photo mosaics of questionable accuracy. On one project, it was learned only after much measuring and head scratching that a chunk of land the size of Banff had 'vanished' to allow the draftsperson to adjust for distortion and get the roads to join up. These problems are particularly critical in proximity to sensitive environmental features such as an archaeological site or animal den where a matter of 50 m may make the difference between no impact and total destruction.

There are several practical solutions to these detailed facility location problems. First, a sufficient buffer should be maintained around critically sensitive sites. Second, the surveyor should be instructed to be on the lookout for sensitive sites and to make slight adjustments to avoid other problem areas such as sidehills and poor water crossing approaches. Third, and better yet, the site boundary or route should be walked by the environmental planner during survey to 'fine tune' the location before the construction equipment arrives. The environmental planner can also make note of likely places for temporary access to the work area and where extra work area is required to accommodate extensive grading.

Contractual Documents (No. 6)

Most energy facilities are built by a contractor working for the owner company. Normal engineering documentation for construction consists of construction plans, specifications and supporting drawings and line lists. These documents form the basis for the contractual agreement between the owner company and contractor, are legally binding and, as such, are enforceable by the company's inspector.

An Environmental Impact Assessment is usually not submitted to a contractor. If submitted, however, it is strictly for information only. Consequently, its provisions bear no weight and can be legally ignored. Environmental Protection Plans are normally submitted as an attachment to the construction specifications. Although this is somewhat of an improvement, the Plan is less likely to be implemented by the company's inspectors and more likely to be overlooked or regarded as an extra. The preferred case is to incorporate the measures in the Plan directly into the contractual documents by using the construction plans as the EPP Reference Maps and by integrating the EPP Report into the construction specifications. Thus the EPP should be organized under the same headings as the construction specification book. The ideal case is that the environmental protection measures are directly incorporated without the use of the word 'environment'. Thus, the contractor is unsure whether the measure is for engineering or environmental purposes and is more likely to carry through with it.

The importance of incorporating environmental protection measures into the specifications cannot be overstated. The specifications are the link between planning and construction. All subsequent environmental protection activities will fail if the link is missing. In the author's mind, the environmental sensitivity of an owner company is best judged by examining its specifications book, rather than its Environmental Impact Assessments.

Environmental Education (No. 7)

The goal of environmental education is to encourage construction personnel to think and act in an environmentally responsible manner. Environmental education is the single-most important long-term solution to environmental protection during construction since some of the other activities discussed below will not be applied to every project. The following passage on quality control is particularly relevant to environmental education:

> "Only the one who actually does the work can control the quality during construction. An inspector or supervisor can stand over a workman and tell him how to do something, but in the end the former cannot move the hands of the latter and cannot manipulate his brain that directs his hands. This is why training is so important in developing not only the proper skills to attain the quality desired, but also the proper attitudes." (Abdun-Nur, 1970: 128)

Most attempts at environmental education are low-key and informal, consisting of a pocket-sized field manual of do's and don't's or a half-hour slide or movie presentation. More substantial environmental education efforts take the form of 1-3 day long courses run at the start of major projects such as on the Norman Wells Pipeline currently under construction. A major impediment to training courses is that contractors expect to be compensated for the time their crews spend in the classroom. On a large project, one day's worth of salaries and expenses can easily total $300,000. It is unfortunate that these costs often force project managers to cancel or abbreviate a course which could easily have saved ten times the cost later in repairs for unnecessary environmental damages. This fact has been recognized in an editorial by a Canadian contracting journal: "By showing more concern for the environment in the first place, contractors will spend much less time later when they return to make good on repairs and damage", (Engineering and Contract Record, 1976). This passage reflects an improved attitude of the construction industry towards environmental protection, particularly if the environmental requirements reflect common sense and practicality.

Environmental Inspection (No. 8)

Inspection is an integral part of constructing any facility. Through its inspectors, the owner company can impose legal or financial penalties on the contractor, or offer incentives to ensure compliance with the specifications. Normally, the owner company will assign an inspector to oversee every major construction activity. These 'activity inspectors' work through a chain of command to the Chief Inspector and Project Engineer. The inspection team is crucial to maintain quality control, whether it be for engineering or environmental specifications (Task Committee on Inspection, 1975).

When environmental protection measures started finding their way into construction specification books, they were foreign to most construction inspectors who either enforced them in token fashion or not at all. However, token implementation of environmental protection measures negates all pre-planning efforts, as the following examples will serve to illustrate. In one case the contractor installed a temporary bridge for vehicular access and then proceeded to drive through the creek anyway. When asked why, the contractor replied that the specifications called for him to install a bridge but not necessarily that he must use it. In another instance, a contractor who was supposed to flume a creek decided to open cut it and lower the pipe in. At this point he installed a flume for the benefit of the government surveillance officer scheduled to make a field visit that day. Other examples of inadequate inspection include: bulldozers taking short cuts through the bush to get to the coffee truck on the other side; decking salvaged timber in places inaccessible to hauling trucks; inaccurate topsoil stripping and poor separation from spoil piles; excessive grading; and seeding at the wrong time of year with three-year-old seed. While contractors insist they will rectify the situation during clean-up, cosmetic solutions are no substitute for effective environmental protection. "Returning to make good is not the answer ... by then it's too late because the damage has been done", (Engineering and Contract Record, 1976). In almost all cases environmental protection is a by-product of good construction practice and is just plain common sense.

The gap between environmental planning and implementation has led to the assignment of Environmental Inspectors whose sole responsibility is to enforce environmental specifications. Case studies on powerline and pipeline projects respectively have been reported in the literature by Tillman (1976) and Mutrie and Dorney (1981).

In Canada, environmental inspection started in the early 1970's, principally on pipeline construction projects. Since then, it has been used on a wide range of projects including the twinning of the Trans-Canada Highway through Banff National Park. The Environmental Inspector normally reports to the Chief Inspector and has the same powers and authority as an Activity Inspector. Figure 5 shows where the Environmental Inspector typically fits into the chain of command. A special status is not necessary, although the Environmental Inspector is somewhat special in that he roves from one activity site to another and has direct access to the Project Engineer and the Environmental Planner. The Environmental Inspector generally acts as the contact between government surveillance agencies and the Chief Inspector.

The use of environmental inspection by an owner company is sometimes voluntary but more often a commitment to satisfy a condition of approval.

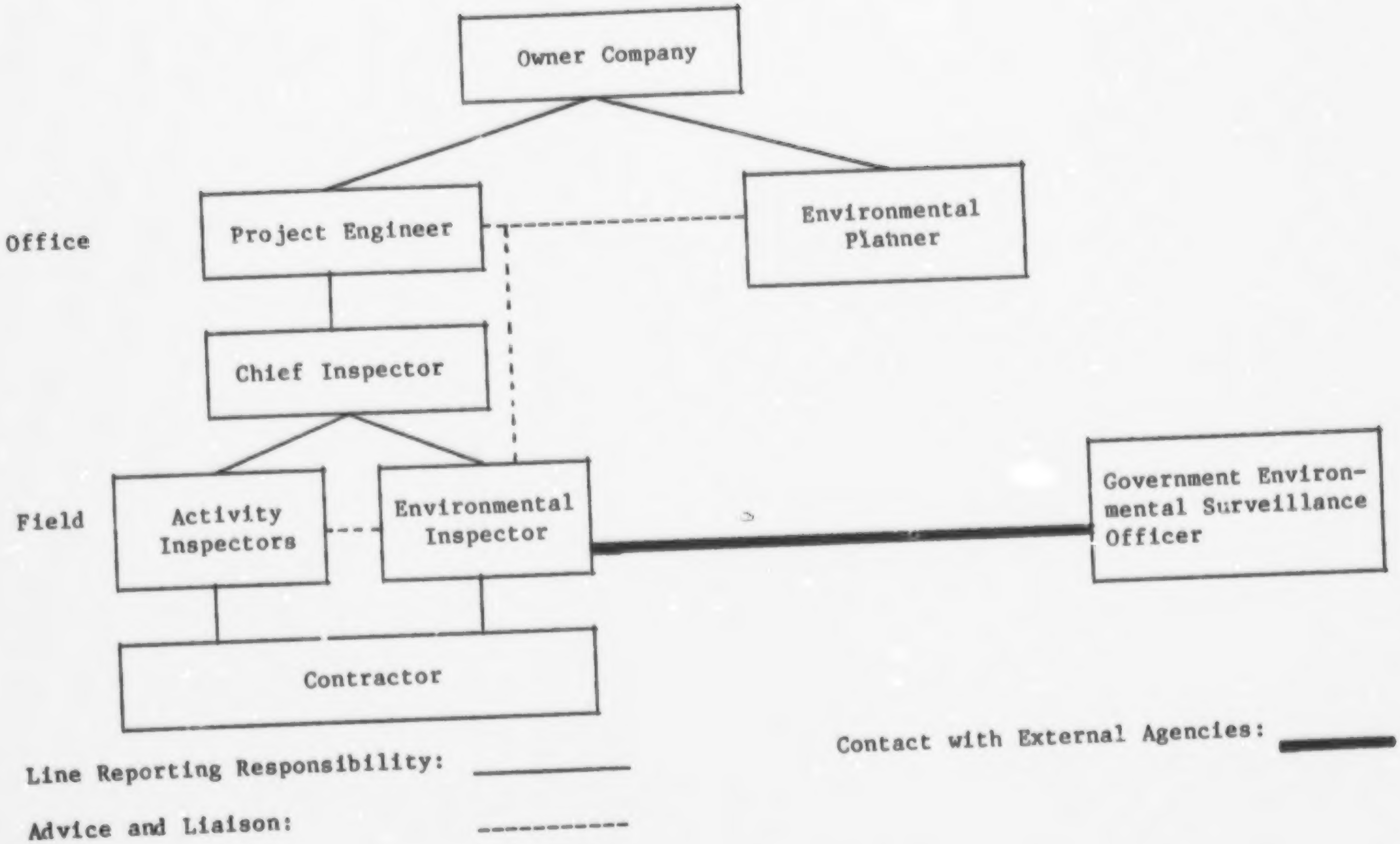
Owner Company
Office
Project Engineer
Environmental Planner
Chief Inspector
Field
Activity Inspectors
Environmental Inspector
Government Environmental Surveillance Officer
Contractor
Line Reporting Responsibility:
Advice and Liaison:
Contact with External Agencies:

Figure 5: TYPICAL LOCATION OF ENVIRONMENTAL INSPECTOR IN CONSTRUCTION CHAIN OF COMMAND

Environmental inspection is particularly appropriate if the facility is located in a sensitive environmental area such as a National Park, Eastern Slopes, Critical Wildlife habitat or the Great Sand Hills. In the case where the most environmentally appropriate site or route was not selected, environmental inspection should be strongly considered.

Successful environmental inspection can make several important contributions to environmental planning. First and foremost, environmental inspection provides the required follow-through by ensuring that the environmental protection measures are properly implemented. Otherwise, all earlier planning efforts amount to nothing more than an expensive academic exercise. Second, it is almost impossible to plan for every detailed environmental protection measure and contingency during construction. The vagaries of weather, ground conditions, workers and regulatory agencies militate against making Environmental Protection Plans too detailed. Hence, the Environmental Inspector can interpret the intent of measures in the Plan in light of changing or unanticipated field conditions. Third, environmental inspection can improve the quality of environmental planning via the feedback loop in the planning process. In practical terms, this means that the Environmental Planner can learn from the Environmental Inspector why certain specified protection measures are ineffective in the field.

Other benefits of environmental inspection include reinforcing environmental education on a day to day basis, helping the Activity Inspectors and Chief Inspector to carry out their work and assisting those involved in surveillance and monitoring, two aspects to be examined shortly.

Unfortunately, environmental inspection is not always effective for a variety of reasons ranging from the lack of training of the Inspector to a lack of authority on the job site. Prerequisites for effective environmental inspection have been identified by Mutrie and Mulamoottil (1980) and are not covered here apart from stating that good communication skills are essential.

Environmental Surveillance (No. 9)

Environmental surveillance is an activity undertaken or sponsored by a regulatory agency to ensure that the environmental protection measures stipulated as conditions of approval are implemented during construction, and that all statutes and regulations are complied with. Surveillance efforts range from the Northern Pipeline Agency's role on the Alaska Highway Natural Gas Pipeline Pre-Build to the local forest ranger periodically keeping an eye on a project in his or her district. Surveillance is necessary to reinforce the company's inspection efforts but Surveillance Officers should guard against directing construction activities.

Environmental Monitoring (No. 10)

Monitoring refers to field activities entailing the periodic or continuous collection of data throughout project stages to: measure environmental changes; determine the effectiveness of environmental protection measures; revise the operational mitigation accordingly; and design better environmental management programs and practices (Reid and Saremba, 1983). Quantitative monitoring of alternative environmental protection measures is of great importance to defining tolerable and intolerable levels of impact. For example, how much sediment can safely be carried by a stream?; when should wet soils not be worked?; and how many vehicular passes can be allowed until soil compaction and rutting are difficult to relieve? Without answers to these kinds of questions, the same mistakes will continue to be repeated.

As-Built Environmental Evaluation (No. 11)

It is sometimes useful to prepare an As-Built Environmental Report describing the success or failure of environmental protection measures, the usefulness of the Environmental Protection Plan and recommendations for future projects. As-Built Reports are required for pipeline projects falling under jurisdiction of the National Energy Board and have occasionally been requested by other jurisdictions such as Alberta Environment. Whether a requirement or not, preparation of an As-Built Report is an excellent idea to document the success of evolving environmental protection measures for the benefit of future projects.

CONCLUSION

The previous discussion has indicated on numerous occasions that unless the appropriate environmental protection activities take place, the original facility location efforts can be wasted. From a cost perspective, the original EIA studies require anywhere from 2-4% of total project cost. As a comparative example, environmental inspection costs generally run about 0.1 to 0.5% of total project costs. Yet environmental inspection can make a much stronger contribution to the environmental quality of the project than EIA. Fortunately many environmental planners are beginning to recognize this fact and are looking at ways to ensure environmental protection beyond facility location.

ACKNOWLEDGEMENTS

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BIOGRAPHY

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FACILITY SITING IN URBAN AREAS:
THE OTTAWA-CARLETON ENERGY-FROM-WASTE/DISTRICT HEATING PROJECT

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ABSTRACT

This paper describes the process used to select a site for a proposed energy-from-waste facility in the City of Ottawa. A three-phased screening process was used to narrow down 22 potential sites to a preferred and an alternative site. Both inclusion/exclusion and comparative criteria were used in the process with the final result being determined by a weighting and rating technique. The siting process used for the Ottawa-Carleton facility is compared with those used in the siting of other energy facilities in Ontario, Quebec, and Prince Edward Island in order to identify urban siting trends in Canada.

INTRODUCTION

The purpose of this paper is to describe the process used in selecting a site for an energy-from-waste facility proposed for the City of Ottawa. This description is followed by a discussion of the processes used to site three other energy facilities in urban areas, in order to illustrate the range of methods used in formal siting of energy facilities in urban Canada.

The facility siting exercise was conducted as part of a three-phased feasibility study under the joint sponsorship of the Ontario Ministry of Energy, Public Works Canada and the Regional Municipality of Ottawa-Carleton. Ontario Hydro provided project management for the study.

The initial siting study (DCH, 1982) was carried out in Phase I, concurrently with initial technical and economic studies. The preferred site in Phase I was designated the "reference site" for the remainder of the study; however, the outcome of the initial siting exercise was reviewed in Phase III of the study when more detailed technical, economic, environmental and social information became available.

The facility itself was eventually defined as a 1200 tonne per day mass burning energy converting facility. At the outset of the study, several size and technical options were under consideration. The siting team was asked to assume the following details about the plant:

(1) Technology
- either mass burning on grate, or semi-suspension burning with solid waste preparation

(2) Land Requirements
- either 2 ha (mass burning) or 4.9 ha (semi-suspension burning with solid waste preparation)

(3) Type and Delivery of Solid Waste
- municipal and commercial solid waste, delivered by truck

(4) Output
- energy in the form of steam at 200 psig, delivered to the existing Cliff Street Central Heating Plant, the mainstay of the district heating system for federal government buildings in downtown Ottawa. (The feasibility of interconnecting the plant with one or both of the other Public Works Canada central heating plants supplying energy to the Booth and Tunneys Pasture complexes, was also under consideration.)

(5) Water Requirements
- an undefined quantity of water, mainly for boiler blowdown, feedwater replacement, and excess steam condensation.

It should be noted that the concept of energy-from-waste was under consideration in the National Capital Region for almost a decade prior to the study described in this paper. A preliminary concept and plant design was produced under the Ottawa Master Plan Extension Study in the mid-1970's for a site selected by an intergovernmental committee. The project was never implemented, and a change in purpose, potential sponsors, energy requirements and waste volumes required that a new start be made.

PROCESS AND METHODOLOGY

The objective of site selection is to select a "best" site from a number of possible sites or within a specified area. There are many methods available to accomplish this. Most of them utilize a phased or stepwise approach to screen out sites which appear to be unsuitable early in the exercise, so as to concentrate efforts on a lesser number of more suitable sites.

A review of the methods used to evaluate and compare sites and their potential application to the overall feasibility study led to the selection of the methodology illustrated in Figure 1. The screening process was divided into three phases. In Phase I, eligible sites were screened using broad inclusion and exclusion criteria. The sites which survived this screen proceeded to Phase II, where the application of weighted administrative, social, environmental, engineering and economic criteria produced a ranking of the potential sites. Only the top three passed into Phase III as candidate sites. The scoring of candidate sites by more detailed criteria in the final screen determined the recommended and first alternative sites.

The site selection methodology was part of the overall site selection process which is illustrated in Figure 2. The initial activities consisted of a general review of site selection methodologies and background studies from other energy-from-waste projects, a review of literature from the previous EFW studies in the National Capital Region, and the identification of potentially suitable vacant sites in the Region. These steps led to the development of the process, formulation of criteria and an initial list of potential sites. The initial criteria determined the information gathered for each eligible site, which, in turn, influenced the cut-off points used for criteria rating categories.

FIGURE 1

OTTAWA-CARLETON ENERGY-FROM-WASTE/DISTRICT HEATING PROJECT

Site Selection Methodology

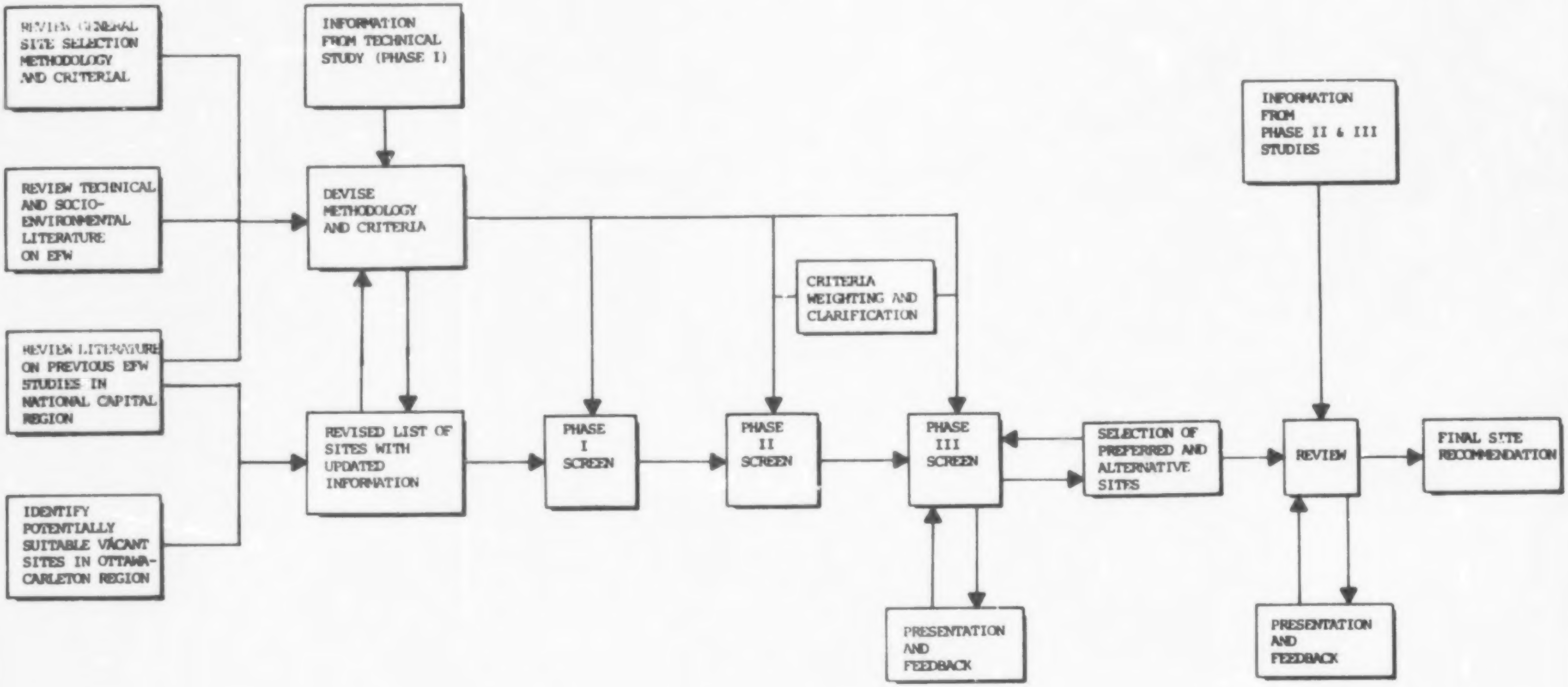
I PHASE I SCREEN I PHASE II SCREEN I PHASE III SCREEN I

Eligible Sites	Potential Sites	Candidate Sites	Recommended Site Recommended Alternative Site
• Inclusion Criteria • Exclusion Criteria - Land Use - Technical	• Administrative Criteria • Social/Environmental Criteria • Engineering/Economic Criteria	• Administrative Criteria • Social/Environmental Criteria • Engineering/Economic Criteria	

INCREASING DETAIL OF MEASUREMENTS-------------------------------→

FIGURE 2

SITE SELECTION PROCESS


REVIEW GENERAL SITE SELECTION METHODOLOGY AND CRITERIAL
REVIEW TECHNICAL AND SOCIO-ENVIRONMENTAL LITERATURE ON EFW
REVIEW LITERATURE ON PREVIOUS EFW STUDIES IN NATIONAL CAPITAL REGION
IDENTIFY POTENTIALLY SUITABLE VACANT SITES IN OTTAWA-CARLETON REGION
INFORMATION FROM TECHNICAL STUDY (PHASE I)
DEVISE METHODOLOGY AND CRITERIA
REVISED LIST OF SITES WITH UPDATED INFORMATION
PHASE I SCREEN
PHASE II SCREEN
CRITERIA WEIGHTING AND CLARIFICATION
PHASE III SCREEN
PRESENTATION AND FEEDBACK
SELECTION OF PREFERRED AND ALTERNATIVE SITES
INFORMATION FROM PHASE II & III STUDIES
REVIEW
PRESENTATION AND FEEDBACK
FINAL SITE RECOMMENDATION

The list of 22 eligible sites was narrowed down to six potential sites using inclusion and exclusion criteria in the Phase I screen.

Prior to the implementation of the remaining screens, it was necessary to clarify and weight the comparative criteria that were developed early in the study. The process used for this task was adapted from the Delphi and Nominal Group Process Techniques for arriving at group consensus. The process involved the use of both a written questionnaire and oral discussion.

The group established to determine the criteria weighting was the Site Selection Steering Committee. The organizations represented on the Committee were the City of Ottawa, Regional Municipality of Ottawa-Carleton, Public Works Canada, Ottawa Community, National Capital Commission, Ontario Ministry of Energy, Ministry of Environment, Ministry of Natural Resources, Energy, Mines and Resources Canada, Environment Canada and Ontario Hydro.

It was understood that no one on the committee was an expert on all aspects of the criteria and that each member had a different perspective based on the degree of prior involvement in similar projects, professional orientation and the organization represented. The process to determine the criteria weighting is presented below.

Notes on the criteria and their rationale were mailed with a weighting questionnaire to the members of the Site Selection Steering Committee. Individual weightings were received prior to a meeting established to finalize the criteria and weighting scheme.

At the meeting, a summary of the initial results was distributed. Each participant explained his criteria weighting rationale. Questions raised by the group members to clarify criteria rationale were addressed by the consultant team and the group so that each criterion was understood in the same way by all group members. The feedback and discussion process exposed each participant to the views of others prior to the final weighting determination.

Following the discussion, each participant reweighted the criteria. The weights were averaged and presented at the close of the meeting. There was a noticeable change in the average weightings as a result of the exercise.

The criteria weighting scheme developed from the meeting was utilized in the two remaining screens. The initial site recommendations were made following a review session with members of the project's Executive and Technical Committees. The top ranked site became the "Reference Site" for the remainder of the project, but the three candidate sites remaining after the Phase II screen were re-examined in light of new information available at the end of the feasibility study prior to the issuance of a final siting recommendation.

A major problem encountered in implementing the process was the difficulty in obtaining the relevant information on plant design and costing when needed. This was overcome by estimating these factors from preliminary data on the plant and by using information on comparable plants in Canada where appropriate. The assumptions made in generating and evaluating criteria are discussed in the appropriate sections of this paper.

RESULTS

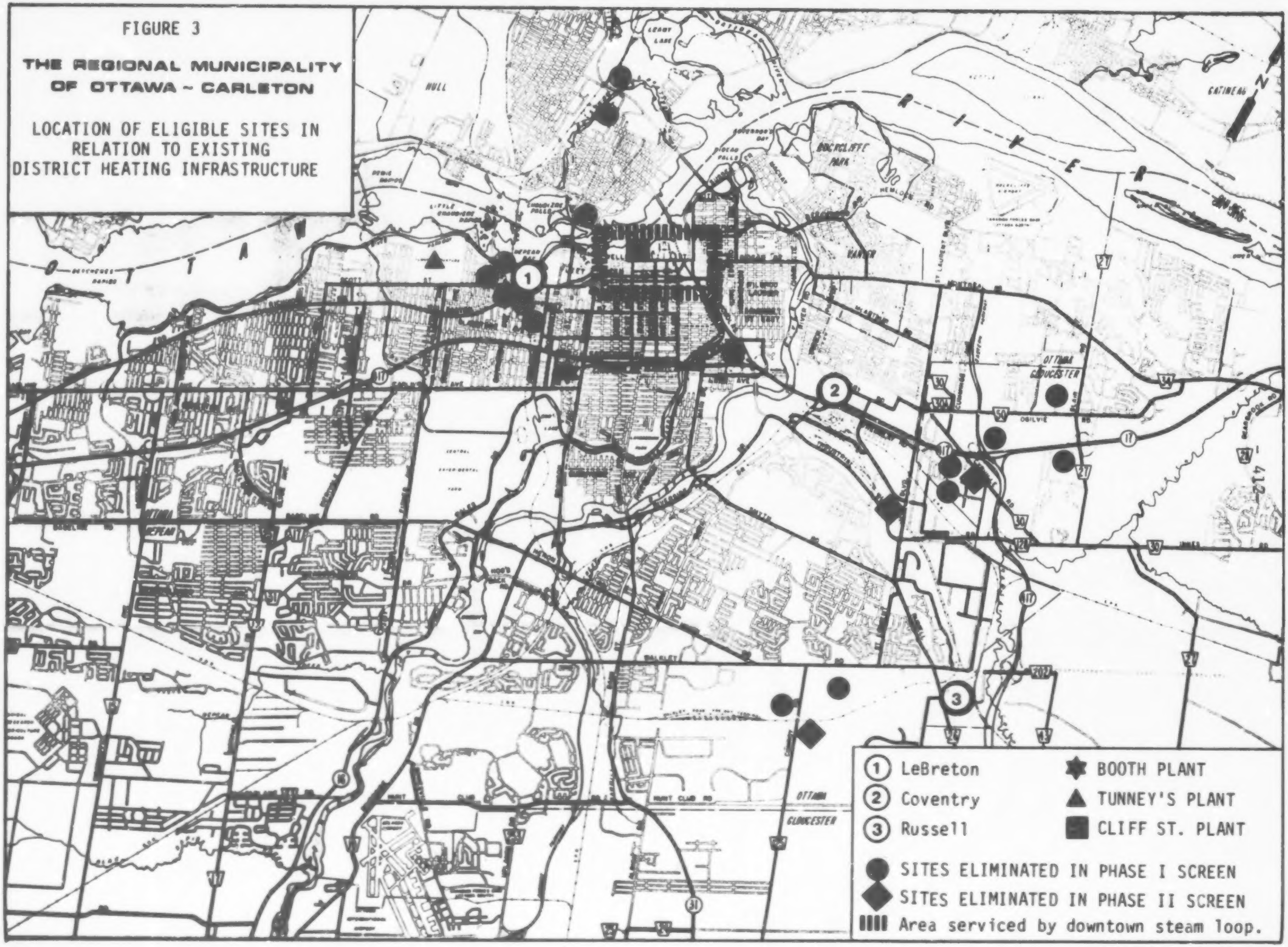
Phase I Screen

The Phase I screen consisted of one inclusion criterion and six exclusion criteria applied to the 22 initially eligible sites. Figure 3 shows the location of these sites in relation to the existing central heating plants and the downtown Ottawa steam loop.

FIGURE 3

THE REGIONAL MUNICIPALITY OF OTTAWA - CARLETON

LOCATION OF ELIGIBLE SITES IN
RELATION TO EXISTING
DISTRICT HEATING INFRASTRUCTURE



O T T A W A R I V E R
HULL
GATINEAU
ROCKCLIFFE PARK
OTTAWA
GLOUCESTER
NEPEAN
OGILVIE RD
HUNT CLUB RD
ST LAURENT BLVD
412
1
2
3
① LeBreton
② Coventry
③ Russell
✡ BOOTH PLANT
▲ TUNNEY'S PLANT
■ CLIFF ST. PLANT
● SITES ELIMINATED IN PHASE I SCREEN
◆ SITES ELIMINATED IN PHASE II SCREEN
▮▮▮▮ Area serviced by downtown steam loop.

The screening process used in Phase I is diagrammed in Figure 4, while the rationale for each criterion is presented below.

(1) Inclusion of Top Three Sites

To be automatically passed into the Phase II Screening, the site had to be one of the three top ranked sites of the Ottawa Master Plan Extension Study. This was requested by the Executive Committee.

(2) Land outside 8 km radious of Cliff Street steam plant

It was assumed that very little could be gained by considering sites further than the distant location of the Walkley site (one of the three top ranked sites in the Ottawa Master Plan Extension Study), since distance to the downtown steam loop is a critical site selection factor. It is uncertain whether a steam plant located as far as 8 km from the heating load can be viable given the technology options under consideration. There are no examples of steam plants currently in operation further than 5 km from its heating load. Thus the Walkley site was assumed to set the outside limit of what could be possible with respect to distance from the steam loop.

(3) Built up Areas

All built up areas were excluded because they were considered not readily available.

(4) Unsuitable Vacant Sites

Vacant sites that did not have good road access or whose shape could pose a severe plant design constraint were excluded.

(5) Location in the Ottawa-Carleton Region

The site had to be located in the Ottawa-Carleton region because jurisdictional difficulties may arise from the trucking of waste from the Ottawa-Carleton Region to an incineration plant located across the Ottawa River in Quebec.

(6) Land Requirements

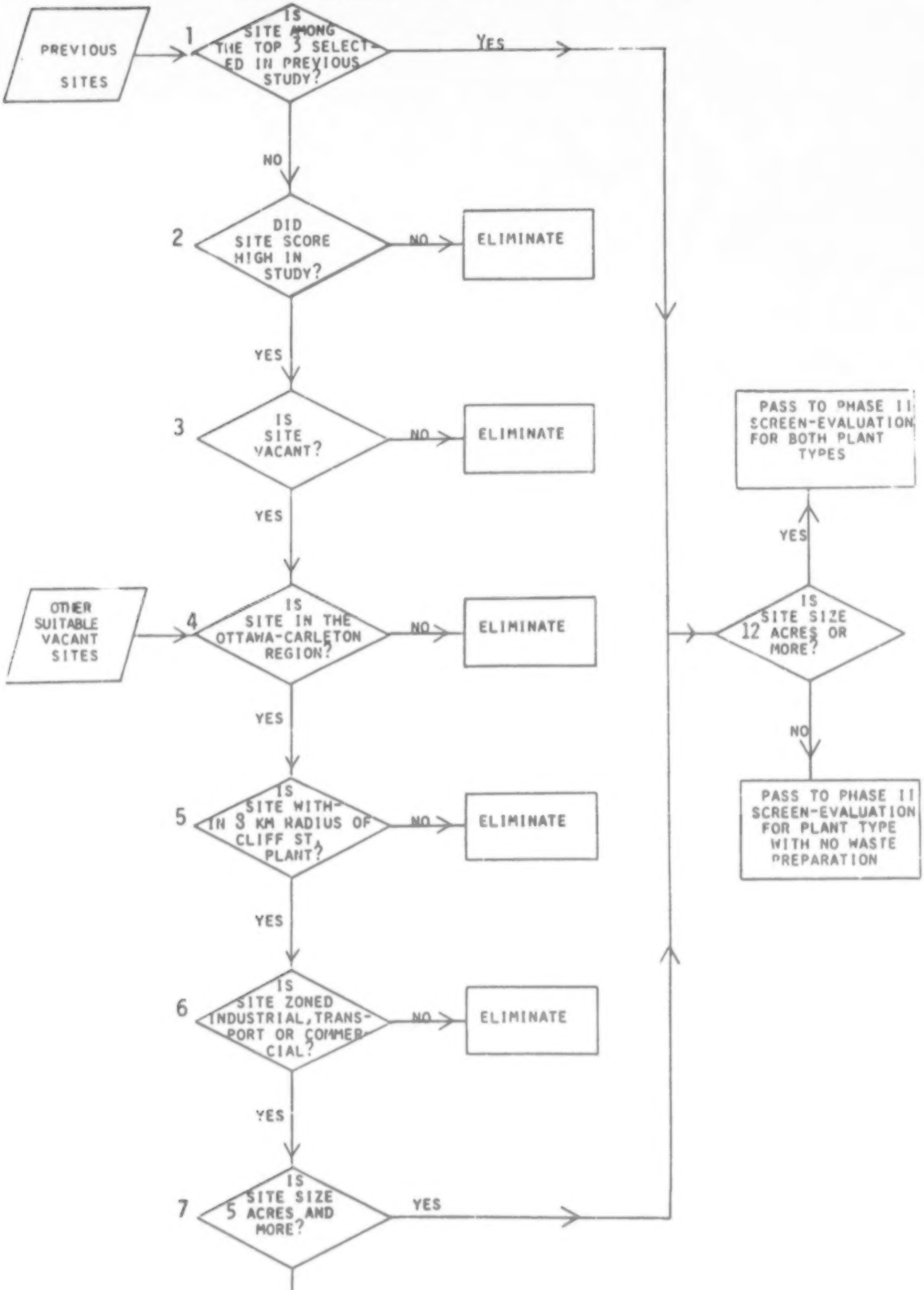
It was established in the early technical studies that aproximately 2 ha (5 acres) would be required for a mass burning plant and 4.9 ha (12 acres) for a semi-suspension burning plant with solid waste preparation.

(7) Zoning

The site had to be under industrial or commercial zoning. It is evident that there is a much greater chance of obtaining approval to locate the plant in these land use zones than in other zones.

FIGURE 4

SITE SELECTION: PHASE I SCREEN


PREVIOUS SITES
1
IS SITE AMONG THE TOP 3 SELECTED IN PREVIOUS STUDY?
YES
NO
2
DID SITE SCORE HIGH IN STUDY?
NO
ELIMINATE
YES
3
IS SITE VACANT?
NO
ELIMINATE
YES
OTHER SUITABLE VACANT SITES
4
IS SITE IN THE OTTAWA-CARLETON REGION?
NO
ELIMINATE
YES
5
IS SITE WITHIN 8 KM RADIUS OF CLIFF ST. PLANT?
NO
ELIMINATE
YES
6
IS SITE ZONED INDUSTRIAL, TRANSPORT OR COMMERCIAL?
NO
ELIMINATE
YES
7
IS SITE SIZE 5 ACRES AND MORE?
YES
NO
ELIMINATE
IS SITE SIZE 12 ACRES OR MORE?
YES
PASS TO PHASE II SCREEN-EVALUATION FOR BOTH PLANT TYPES
NO
PASS TO PHASE II SCREEN-EVALUATION FOR PLANT TYPE WITH NO WASTE PREPARATION

Nine of the 22 eligible sites survived the Phase I Screen. Since a number of these sites are in close proximity to one another, it was decided that only the best of the sites grouped in one location would be passed to the Phase II screen. This reduced the number of sites for further consideration to six.

Phase II Screen

The objective of this screen was to reduce the number of potential sites to two or three candidate sites for the final screen. To achieve this, we used ten classed criteria. Potential sites were scored by a conventional rating and weighting technique.

Criteria were derived from three data sources; documents from the previous EFW study in the National Capital Region, other site selection studies and other EFW studies. The important considerations applied to criteria development were; to eliminate factors which were no longer relevant or under consideration (e.g. refuse from the Outaouais Region); to frame criteria with minimum of overlap; and establish an objective process of evaluation by developing criteria measurements whenever possible.

The ten criteria used in Phase II are explained in Table 1. Each criterion was given three rating classes for scoring purposes.

The application of the Phase II screen resulted in the elimination of three sites from further consideration. The three remaining candidate sites; LeBreton Flats, Coventry and Russell (see Figure 3), were passed into the final screen.

Phase III Screen

The criteria used in the Phase III screen are similar to those used in Phase II, but are considered at a much higher level of detial. Seven criteria were utilized in Phase III. The first six criteria remained essentially the same as those in the Phase II screen while the seventh, the Site-Related Capital Cost Criterion is a combination of the last four Phase II criteria. This criterion summarizes the capital costs attributable to differences in site location.

Site ratings in Phase III were expanded to a 10 point system. The site with the best score was accorded a full rating, while ratings of the other two sites were made proportional to that of the highest scoring site.

A description of each criterion is presented below, along with its relative weighting. The weighting scheme was basically conserved from Phase II, with some minor adjustments to account for criteria changes between phases.

(1) Ease of Acquisiton (Weighting: 7 percent)

Essentially the same as in Phase II, but expanded to a 10 point scale.

(2) Land Use Compatibility (Weighting: 6 percent)

An expansion of zoning criterion in Phase II. Specific land uses in two concentric bands around the site were rated on a 5 point system. A total score for each site was calculated by multiplying the percentage of each band by its rating category and double weighting the inner band.

TABLE 1

PHASE II CRITERIA

Category/Issue	Criterion	Rationale	Weighting
I. ADMINISTRATIVE			(13)
(1) Ease of Acquisition	Availability for purchase	Land most available for purchase is easiest to acquire	7
(2) Zoning	Present city zoning	Measure of compatibility with existing city plans	6
II. SOCIAL/ENVIRONMENTAL			(40)
(1) Proximity to Residential Areas	Distance of site center to boundary of nearest residential area	Indirect measure of impact on nearest residential area. Site centre used to not prejudice larger sites, which may not be fully developed	20
(2) Neighborhood Traffic-Nuisance	Length of residential streets traversed by most likely route	Assumes distance through residential streets is proportional to degree of traffic nuisance	14
(3) Recreational Impact Factor	Distance of site center from nearest active recreation site	Indirect measure of impact of plant on urban recreation	6
III. ENGINEERING/ECONOMIC			(47)
(1) Plant Water Requirements	Distance to nearest river	River water will be used for system make-up and cooling	6
(2) Proximity to Major Transportation Route	Estimated time required to reach site from Queensway	Measure of accessibility and convenience for solid waste delivery from all part of Region	7
(3) Convenience to Landfill Site	Estimated time required to travel from site to landfill	Approximately 30 percent of refuse mass (less recycleables) will be landfilled	4
(4) Distance from Cliff Street Plant	Distance from site to Plant along existing road network	Assumes interconnections buried under roadways	23
(5) Suitability for Site Development	Rate site terrain from available information	Assumes less suitable terrain increases development costs	8

(3) Residential Disturbance (Weighting: 20 percent)

Considers the residential population within each of the two concentric bands employed in the Land Use Compatibility Criterion. The inner band is double weighted.

(4) Traffic Nuisance (Weighting: 14 percent)

Considers the residential and pedestrian populations along major delivery routes anticipated for each site, as well as the percentage increase in truck traffic likely to be experienced along each route. Sites were scored by multiplying the sum of residential and pedestrian populations by the percentage increase in truck traffic along a route segment and summing the results for all segments.

(5) Recreational Impact (Weighting: 6 percent)

This criterion was expanded to include all recreational sites within .5 km of the site as well as sites along the collector truck routes. Each recreational site was given an impact factor based on its significance and the potential for disturbance. Impact factors were summed for all recreational sites potentially affected by a facility on a given site.

(6) Transportation Time (Weighting: 11 percent)

This criterion was expanded from the two related criteria in Phase II to compute the total amount of time required to deliver refuse to the plant and truck ash to the landfill site. Calculations were based on estimated volumes of refuse coming from seventy geographic areas within the Region.

(7) Site-Related Capital Costs (Weighting: 36 percent)

This criterion measures capital costs attributable to the plant location, as opposed to total capital costs of the plant. The costs considered were land and development costs, connection to electrical networks and the cost of steam and condensate lines to the Cliff Street Plant. Most of these costs had to be computed from tenuous assumptions because plant design work had not been completed. The cost of cooling water delivery and return lines was dropped from consideration as it was decided that air cooling would be used if the site was far from the Ottawa River.

The results of the Phase III screen are summarized in Table 2, and clearly show the importance of weighting factors to the outcome of the study. In order to determine the sensitivity of the analysis used to the assigned weights, the weights accorded to the three most heavily weighted criteria were varied, one at the time, by 20 percent. (The weighting of all other factors was proportionately adjusted.) It was found that the LeBreton site would score highest in any case. Through a series of trials, it was found that in order for another site to replace LeBreton as the preferred site, the weighting of

TABLE 2

RESULTS OF THE PHASE III SCREEN

SITE SELECTION CRITERIA		SITES					
	WEIGHTING	LEBRETON		COVENTRY		RUSSELL	
		RATING	SCORE	RATING	SCORE	RATING	SCORE
1. EASE OF ACQUISITION	7	10.0	70.0	3.4	23.8	3.4	23.8
2. LAND USE COMPATIBILITY	6	6.5	39.0	8.3	49.8	10.0	60.0
3. RESIDENTIAL DISTURBANCE	20	2.3	46.0	3.2	64.0	10.0	200.0
4. TRAFFIC NUISANCE	14	2.9	40.6	10.0	140.0	6.7	93.8
5. RECREATIONAL IMPACT	6	1.3	7.8	10.0	60.0	3.8	22.8
6. TRANSPORTATION TIME/ COST	11	9.5	104.5	10.0	110.0	7.8	85.8
7. SITE-RELATED CAPITAL COST COMPOSITE	36	10.0	360.0	2.8	100.8	1.7	61.2
TOTAL SCORE			667.9		548.4		547.4
RANK			1		2		3

the site-related capital cost had to be reduced to 24 percent. Such a low weighting on the economic factors would infer that viability was not critical to the final decision. This was clearly not the case and it is unlikely that the importance of economic factors would slip to a point where less than a quarter of the weighting were allocated to it.

One other issue of clear importance to the outcome was the use of incremental site-related capital costs instead of total costs in the economic criterion. Total costs are often compared in siting studies; however, economic considerations are normally accorded a much higher relative weighting as well.

In this case, it was felt that the magnitude of difference in costs between sites was large enough to create significant uncertainty as to the viabiwity of any incineration plant proposal located on a site distant from the heating load. Thus, as one moves from LeBreton to Coventry and to Russell, the likelihood of being able to justify the additional $20 to $40 million in expenditure becomes very doubtful. This is reflected in the economic criterion used.

Site Selection Addendum

The Phase I site selection report completed in October, 1982 indicated that the LeBreton Flats site was significantly superior to the Coventry and Russell sites from an economic point of view, but from an environmental/social point of view, had definite disadvantages. The Site Selection Addendum produced in June, 1983 (DCH, 1983d) was intended to re-evaluate the two sites based on the new technical, financial, environmental and social information which became available during Phases II and III of the feasibility study.

LeBreton Flats was chosen as the reference site for the detailed technical studies as a result of the initial site selection process. Nevertheless, some of the assumptions used in producing the first site selection report were evaluated during Phase II with a view to determining their impact on site scoring. The most critical of these were (a) the assumed necessity of connecting the EFW plant directly into the Cliff Street Plant, and (b) the assumption that the only steam loads which could be serviced by the EFW plant were the Cliff, Tunney's and Booth steam distribution loops. Technical studies revealed that both of these assumptions could be revised to some extent. It was found that a connection could be made at the east end of the downtown steam loop rather than at the Cliff Street Plant itself (refer to Figure 3). This had the effect of reducing the cost of piping from the Coventry site. Other potential loads for EFW steam were identified in proximity to the Coventry site, resulting in a change to the economic results assumed in the Phase I site selection. Since none of these findings had any major implications for the Russell site, it was given no further consideration.

The relative economic advantage of the LeBreton site over the other two sites was eroded by these findings to the point where the Coventry site achieved a slightly higher overall score than LeBreton (Table 3). The economic analysis provided in the technical report (SNC/London, 1983) confirms these results in that the return on investment for the Coventry site was found to be very close to that for LeBreton.

TABLE 3

RESULTS OF THE SITE SELECTION ADDENDUM

SITE SELECTION CRITERIA	WEIGHTING	SITES			
		LEBRETON		COVENTRY	
		RATING	SCORE	RATING	SCORE
1. EASE OF ACQUISITION	7	10.0	70.0	3.4	23.8
2. LAND USE COMPATIBILITY	6	6.5	39.0	8.3	49.8
3. RESIDENTIAL DISTURBANCE	20	2.3	46.0	3.2	64.0
4. TRAFFIC NUISANCE	14	2.9	40.6	10.0	140.0
5. RECREATIONAL IMPACT	6	1.3	7.8	10.0	60.0
6. TRANSPORTATION TIME/ COST	11	9.5	104.5	10.0	110.0
7. SITE-RELATED CAPITAL COST COMPOSITE	36	10.0	360.0	6.4	229.7
TOTAL SCORE			667.9		677.3
RANK			2		1

The scores for the non-economic factors remained the same for this updated analysis. LeBreton was given a very low score as a result of traffic nuisance and residential disturbance. Subsequent public participation and detailed transportation studies (DCH, 1983a&b) confirmed these results.

The overall scores achieved are naturally sensitive to the assumptions upon whch they are based. Any variation in these assumptions or the inclusion of other factors in the equation could change both the scores and the ranking of the two sites. Table 4 identifies areas of potential change and their likely impact on the site scoring.

The first three changes listed on the table are factors which were not considered in criteria, but which assumed a greater degree of importance as a result of public commentary and the Phase III environmental analysis. Air pollution was not considered initally as a siting factor because the area of pollutant dispersion from a tall (75m) stack is large relative to site location differences. However, dispersion modelling in the Environmental Assessment (DCH, 1983c) showed that the presence of tall buildings, particularly at the LeBreton site, could require a much greater stack height than that proposed. Increase in relative stack height, if necessary, should be considered in the Site-Related Capital Cost Composite.

It was concluded that, based on the latest information available from all the technical studies, the Coventry site would be, under most circumstances, the preferred site for the EFW plant. The Executive Committee concurred with this finding and recommended the Coventry site to any future proponent. The question of proponency remains open to date, and it is probable that the site selection study will require one further update before the issue is finally resolved.

SITING OF OTHER URBAN ENERGY FACILITIES

The use of formal methodologies for siting energy facilities in urban areas is not new in Canada, but it is also not commonly practiced. Ontario Hydro and Hydro Quebec have formally sited urban transmission lines and transformer stations since 1975, but to our knowledge, no other Canadian utility companies have been involved in urban (as opposed to rural or forested area) facility siting. Both Ontario and Quebec are required to consider alternative sites in undertakings which require approval under provincial environmental legislation. Similar regulatory requirements probably exist in other provinces, but would not apply to the type of urban energy facilities which are formally sited in Ontario and Quebec.

Another urban energy facility for which siting was required was an energy-from-waste plant in Prince Edward Island. This will certainly not be the last, as there are a number of such plants being proposed in the cities and towns of Ontario for which siting is issue.

Our discussion of urban facility siting will be illustrated by the approaches used to site transmission stations in London, Ontario and Montreal, Quebec and the energy-from-waste plant in Prince Edward Island. The approach used to site a 230-27.6-13.8 KV transformer station in the City of London, as described in Ontario Hydro (1977), is representative of the process used by this utility. A screening process was carried out by a Working Committee which included city officials and members of the public as well as Hydro experts. Twenty-three potential sites were initially proposed within the city core area, on vacant land, unused land or industrial land slated for possible plant relocation.

TABLE 4

IMPACT OF CHANGES IN BASE ASSUMPTIONS OF THE ADDITION OF NEW FACTORS ON THE COMPARISON OF LEBRETON AND COVENTRY SITES

Type of Change	Effect on Score	
	LeBreton	Coventry
(1) Consider planned development on adjacent lands	Decrease	No change
(2) Consider existing visual buffers between site and adjacent residences	Increase	Increase
(3) Consider effect of tall buildings on required plant stack height	Increase	Lesser increase
(4) Increase cost of removing existing landfill material on LeBreton site[1]	Decrease	No change
(5) Decrease cost of removing landfill material	Increase	Lesser increase

---

[1] LeBreton Flats is a former landfill site. It was assumed throughout the analysis that the existing fill would have to be removed below the foundation to render it useable for an idustrial plant.

Five exclusion criteria were utilized in Phase I; relating to minimum land parcel size, access for transformers, access for voltage lines, access to water and sewer services and site availability. These criteria were utilized to narrow down the number of remaining sites to five.

Following the Phase I screening, it was necessary to consider the routing of transmission systems in order to further evaluate the sites. Three sets of criteria were utilized in the Phase II evaluation; system, economic and community planning (social and environmental). These criteria are displayed in Table 5.

The development of an explicit methodology to evaluate trade-offs between types of criteria is not part of the Ontario Hydro site selection process. This type of evaluation was thus qualitative in the London Transformer Station Study. However, for non-economic considerations, preferences are established by criteria weighting and pairwise factor comparison.

The approach used by Hydro Quebec to select a site for the Charland 315-25kv Transformer Station in the Montreal Urban Community illustrates an urban siting approach somewhat different than that previously described.

According to the Charland project report (Hydro Quebec, 1982), the process began with the delimitation of a study area, followed by an overview inventory. Five candidate sites were identified using considerations similar to those of the London Study, but also considering the spacial and visual characteristics of the study area at this stage. The five sites were subjected to comparative evaluation; no further screening mechanism was used.

The comparative evaluation was based upon a synthesis of technical-economic information on each site, and the identification of site impacts. Site impacts were evaluated in matrix form using three sets of criteria; functional (land use), spacial (e.g. traffic patterns and activity nodes) and visual. Visual criteria were especially well-developed, requiring an evaluation from nine different perspectives. The evaluation matrix considered both the intensity of the impact and its localization, using five levels of each measure. Positive as well as negative impacts were scored, as several criteria had aspects of both.

A best site was selected by the collective consideration of technical-economic data and the social-environmental evaluation matrices, synthesized for each set of criteria. Unfortunately, the methodology used to evaluate trade-offs between criteria was not developed in the study.

One other important aspect of the Charland study process was the involvement of key individuals and the local public. Unlike the London study, members of the public were not placed on a siting team. However, consultation and feedback were a formal part of the public participation program conducted by the utility.

The selection of a site for an energy-from-waste plant in the vicinity of Charlottetown, P.E.I. was less formal than the exercises conducted in Ottawa, London or Montreal, but still explicit in the sense that alternative sites were compared along stated criteria and evaluated in a public arena.

Initial site identification was based on three primary considerations; distance to a potential year-round customer, suitable zoning, and socio-economic concerns such as noise and traffic patterns (Hiscock, 1984). Two potential sites were identified; one within the Charlottetown City Limits adjacent to a thermal generating plant, and another in the Town of Parkdale adjacent to a hospital.

TABLE 5

PHASE II SITE SELECTION CRITERIA UTILIZED IN LONDON CENTRAL TRANSFORMER STATION STUDY

I. System Considerations

  1. System reliability
  2. Flexibility for future expansion
  3. Proximity to load centre
  4. Minimization of energy losses

II. Economic Considerations

  1. Initial capital costs
  2. Long term capital costs

III. Community Planning Factors

  1. Effect on residential areas (including schools, parks and churches)
  2. Effect on industrial and commercial areas
  3. Effect on historic sites or areas
  4. Effect on property values
  5. Effect on community attitudes
  6. Compatibility with city planning policies
  7. Effect on potential of existing rail corridors for multiple uses
  8. Effect on protential for future development
  9. Effect on natural systems
  10. Site flexibility for building design and landscaping
  11. Effects during construction

Source: Ontario Hydro, 1977

A comparison of sites was based upon the following criteria; costs for steamlines, site development and facility operation; potential steam revenues; highway accessiblity; and acceptability to nearby residential areas. Interestingly enough, although the Charlottetown site was more highly rated with respect to technical and economic criteria, local opposition to this site caused the P.E.I. Energy Corporation to choose the Parkdale alternative. This indicates the importance which public input can assume in the selection of urban facility sites.

The public was also a factor in the Ottawa-Carleton Energy-from-Waste Project in that public reaction to the initially preferred site caused the Executive Committee to look more closely at steam delivery and customer alternatives for the plant. The additional information generated in this exercise resulted in the subsequent reversal in the ranking of the two best sites.

OBSERVATIONS AND CONCLUSIONS

Formal methodologies to site urban energy facilities have been used in Canada to select locations for transformer stations and refuse-fired steam plants. The practice of urban facility siting dates back to 1975 and has been used for the most part, in Ontario and Quebec. Both of these provinces are required to consider alternative sites in undertakings submitted for government approval.

A review of four Canadian facility siting exercises conducted in urban areas illustrates the continuum of formal and less formal methodologies. The Ottawa-Carleton process was the most formal of the three; it incorporated numerical weighting and rating as a means of evaluating trade-offs between different types of criteria. The P.E.I. process was the least formal; it but did not utilize an explicit means to evaluate trade-offs between siting criteria. The Ontario Hydro process used weighting and pairwise comparison to evaluate trade-offs between non-economic criteria, but did not have an explicit methodology for comparing site performance in economic and non-economic criteria. The Hydro Quebec process was well developed with respect to criteria selection and evaluation, but not in the evaluation of trade-offs between criteria.

Two of the four studies utilized a phased screening process. Phased screening is typical of most siting exercises, as it allows siting teams to concentrate on a progressively smaller number of potentially better sites. However, phased screening is not critical when there are a small number of siting options to consider.

The most significant trend in urban facility site selection, the increasing importance being placed on public reaction to alternative sites, is illustrated in all four studies. The solicitation of public input and the increasing degree of importance being placed on social-environmental criteria are major elements which have emerged in the evolution of facility siting in urban areas.

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TABLE 1

PHASE II CRITERIA

Category/Issue	Criterion	Rationale	Weighting
I. ADMINISTRATIVE			(13)
(1) Ease of Acquisition	Availability for purchase	Land most available for purchase is easiest to acquire	7
(2) Zoning	Present city zoning	Measure of compatibility with existing city plans	6
II. SOCIAL/ENVIRONMENTAL			(40)
(1) Proximity to Residential Areas	Distance of site center to boundary of nearest residential area	Indirect measure of impact on nearest residential area. Site centre used to not prejudice larger sites, which may not be fully developed	20
(2) Neighborhood Traffic-Nuisance	Length of residential streets traversed by most likely route	Assumes distance through residential streets is proportional to degree of traffic nuisance	14
(3) Recreational Impact Factor	Distance of site center from nearest active recreation site	Indirect measure of impact of plant on urban recreation	6
III. ENGINEERING/ECONOMIC			(47)
(1) Plant Water Requirements	Distance to nearest river	River water will be used for system make-up and cooling	6
(2) Proximity to Major Transportation Route	Estimated time required to reach site from Queensway	Measure of accessibility and convenience for solid waste delivery from all part of Region	7
(3) Convenience to Landfill Site	Estimated time required to travel from site to landfill	Approximately 30 percent of refuse mass (less recycleables) will be landfilled	4
(4) Distance from Cliff Street Plant	Distance from site to Plant along existing road network	Assumes interconnections buried under roadways	23
(5) Suitability for Site Development	Rate site terrain from available information	Assumes less suitable terrain increases development costs	8

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BIOPHYSICAL TERRAIN SENSITIVITY MAPPING AS AN INPUT TO LINEAR FACILITY ROUTE SELECTION

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ABSTRACT

The development of soil and vegetation sensitivity rating scales is detailed for two industrial projects: a subalpine access road in northwestern British Columbia, and a natural gas pipeline and processing plant in northwestern Alberta. Following extensive field surveys, limiting factors were chosen on the basis of the physical nature of the proposed disturbance, the value of existing biophysical resources and the particular properties of the soil and vegetation types.

The final terrain sensitivity map was used in conjunction with project engineers to assist in route selection and the location of permanent structures. The terrain sensitivity map also became the basis for implementing site-specific construction methods, materials handling techniques and reclamation procedures to mitigate unavoidable impacts.

OBJECTIVES AND CONTEXT

The exact role and scope of any biophysical investigation carried out for the general purposes of impact assessment must be well understood from the outset. For the system of terrain sensitivity mapping discussed in this paper, the applied background is that of corridor development, although modifications could allow its application to other sorts of industrial activities. The specific objectives which this system was designed to meet were the following:

1) To devise a suitable routing for a corridor and suitable siting for auxiliary structures, based on biophysical considerations and given engineering or economic constraints; and
2) To devise suitable methods of mitigation and reclamation for those areas which must be disturbed.

Such objectives arise in the construction of many utility or transportation corridors, such as roads, railroads, pipelines and transmission lines. In fact, the same problems of site selection and mitigative planning are common to most environmental impact assessment processes. To successfully meet these objectives, a great deal of communication and compromise may be required on the part of project engineers and environmental advisors. In outlining a suitable approach to follow, this paper details the technical aspects of the process; final decisions eventually tend to depend on such sociological factors as profit margins, political pressures, philosophical values of the proponent and the personalities of managers. Given these limitations, it remains the task of the professional environmental scientist to provide the most reliable information and recommendations possible.

The role of terrain sensitivity mapping in an overall program of environmental assessment and planning should also be understood. Route selection and reclamation recommendations may be the only objectives, or they may be components of a much larger environmental impact assessment spanning many disciplines and public concerns. In such a case, environmental planning is best approached as a multi-stage process. Regional impacts and land uses should first be documented at a broad scale (as in the classic "E.I.A." document). Terrain sensitivity mapping then follows at a more detailed level with a much narrower scope once the general value and location of the project have been decided. The final level of detail (if required) then takes terrain sensitivity information and uses it to devise precise site-specific procedures kilometre by kilometre, for the mitigation of impacts (as in a "Development and Reclamation Plan" or an "Environmental Protection Plan").

The existence or importance of these three intensities of study and planning vary among projects and governmental jurisdictions. Their hierarchical relationships can be usefully followed in project development and organization. For the purposes of this paper, however, the broader scope of a full-scale impact assessment and the narrower scope of exact methods for devising site-specific mitigative recommendations will only be alluded to. With different scope and objectives, these activities are best dealt with in separate discussions, not included here.

THE APPROACH AND ITS APPLICATION

A practical approach to terrain sensitivity mapping was gradually developed on the basis of the above relevant background and over the course of several corridor route selection projects. The recommended procedures are detailed in the following discussion, with examples drawn from two recent applications. One example is that of a 45 km access road through subalpine-subarctic terrain near the Stikine River in northwestern British Columbia (Monenco Consultants Pacific Ltd. 1981). This job was commissioned by B.C. Hydro to provide access for geotechnical drilling equipment. The second example is a 75 km system of pipelines in the Saddle Hills of northwestern Alberta (Monenco Consultants Limited 1982a), part of the Progress Gas Development being proposed by Shell Canada. Both projects required route selection recommendations and reclamation planning.

The following discussion is presented in a step-by-step manner so that it can serve as a brief manual for someone carrying out the exercise for the first time. Steps 1 to 5 are often done as part of a general E.I.A., while Step 10 represents a detailed environmental protection plan.

Impact Definition

Prior to any data collection or the development of rating schemes, it is imperative that the exact nature of the proposed development activities be clearly identified and understood. Comprehensive checklists should be compiled of the potential mechanisms of impact and needs of the development project. Common features to consider (and their implications) include the following:

- What will be the season of construction and operation? (Winter impacts are often much less than summer impacts.) Are assessments required for all seasons?

- What will be the swath width or area of disturbance? (It is good to understand the absolute area of proposed disturbance, e.g. a 10 m wide right-of-way implies the disruption of one hectare per kilometre.)

- Will soil or vegetation be purposely removed? Will it be stored and replaced? Will it be salvaged for other uses? (This largely defines the magnitude of disturbance at the onset, and determines whether reclamation must deal with the rebuilding of soils and vegetation or whether it can merely augment natural processes of recovery.)

- What engineering and economic restrictions are there on route length, steepness, rock outcrops and bodies of water? (Costs may prohibit the use of any but minor alterations to a straight-line route; bogs and fens may be desirable terrain types for winter construction, but should be avoided during summer construction.)

- What are the characteristics of the machines to be used in construction? What will be the depths of disturbance, and what are the potentials for accidental gouging, compaction and fire?

- What will be the duration of construction activities? After construction, will the corridor be maintained, upgraded, blocked or abandoned?

- What auxiliary features are associated with the project: construction camps, borrow pits, roads, compressor stations, etc.? (These facilities can often have as great an impact as the primary activity, and they should be carefully sited.)

In the case of the Stikine access road, terrain sensitivity assessment was to be carried out for the possibility of both summer and winter activities. Since a prior study had discussed winter impacts (which were largely negligible), terrain mapping was to emphasize summer features in the event that the proposed scenario of "winter in, winter out" access could not be followed. Swath width was limited to that of the actual vehicles, 3 to 4 m. Since most of the area supported no trees, there was no need to remove vegetation for vehicle passage. Large vehicles were to drive over the plant cover in the hope that it would recover itself. Minor excavations would be required at the approaches to creek crossings. Route length was to be kept minimal, with slopes of more than 15% to be avoided if possible. Terrain consisting of large boulders, ragged rock outcrops and waterlogged soils (and bodies of water) were to be avoided in selecting a summer route. The entire industrial activity would be restricted to the double passage (one in, once out) of four to six wheeled and tracked vehicles, with bearing pressures of 18 to 62 kPa (2.6 to 9 p.s.i.). The tracked vehicles (including a D7 Caterpillar tractor) could be expected to contribute significant gouging and soil compaction. Following vehicle passage, the road was to be blocked and abandoned, with reclamation efforts undertaken if necessary. No associated facilities were to be considered, except the location of a temporary bridge across a narrow chasm.

For the Progress Gas Development, winter construction was also proposed, but assessment was to dwell on the most sensitive season, generally summer. The possibility of both winter and summer construction existed. The pipeline system would join 23 well sites (already in existence) with two compressor stations and a sour gas processing plant. Pipeline construction would consist of clearing a right-of-way of 10 m width, excavating a 1.0 m wide trench, 1.5 m deep, and installing the 0.3 m diameter welded and wrapped pipe. Existing cutlines and roadways were to be used for the right-of-way wherever possible, and maintenance roads would share some of the pipeline corridor after construction. In forested areas, the plant cover would first have to be removed by bulldozer (and commercial timber salvaged if possible), so most of the natural vegetation and upper soil would be destroyed in the right-of-way. Trench excavation would have the potential to leave relatively infertile subsoils or glacial tills on the surface. Cover removal, bulldozing and trenching could disrupt local patterns of drainage, notably by creating straight drainage courses where none existed before.

Depending on weather conditions, dusting could arise as a result of soil being bared during construction, or from the surface of associated gravel roads. Route length was to be kept minimal, and although steep slopes were not a severe limitation to construction, they and areas with shallow soil (less than 2.0 m) were to be avoided when more favourable routes were possible. Locations with standing water year round would also be unacceptable. Construction activities would last 10 to 18 months, after which the corridor would be revegetated. Associated facilities requiring site selection would be 23 km of access roads, two gas-powered compressor stations, and the gas-processing plant. The site would require 80 ha of land, and its siting was to be determined by aspects of plume dispersion and anticipated downwind impact (not discussed here) in addition to local terrain sensitivity.

Resource Identification

A review of existing sources of information should be adequate to identify the natural resources and land uses of the proposed project area. Such an inventory provides a regional context within which to consider corridor alternatives and potential conflicts. Use should be made of Canada Land Inventory maps, land disposition maps, published literature (both popular and scientific) and personal communications with local forest rangers, game wardens, municipal representatives and special interest groups. As a result of this process (often carried out as the "preliminary assessment" component of an E.I.A. or prior to a full E.I.A.), all possible sources of conflict should be identified and the relative value of the terrain for alternative uses should become clear.

Categories of resources to consider would include mineral resources, agriculture, forestry, fisheries, wildlife, watershed properties and uses, archaeological finds and preservation considerations (such as parks, recreational uses, wilderness value and the presence of rare or protected species). In addition to examining the present value and use of such features, it is also worth referencing any assessments or plans for future or potential uses. At this time, it is also prudent that all governmental jurisdictions and requirements (by different agencies) of the proposed development be clarified, and that a co-operative (rather than antagonistic) working relationship be established with all concerned.

The Stikine Plateau is located in a very isolated part of northwestern British Columbia. There is very little human use of the area, the nearest settlement being the village of Dease Lake, about 40 km to the north of the proposed trailhead. The climate is cold and terrain mountainous, with any forests being very sparse, slow-growing and non-commercial. Various minerals leases are present in the area, but most have not yet been explored. Agricultural and fisheries land use is non-existent, although the Stikine River (itself out of the project area) is used by spawning salmon. The major resources in the area are those of wildlife, with Dall sheep, caribou and grizzly bear frequenting the area, as well as a large resident moose population. One of the few human land uses of the area has been big game hunting and outfitting, and limited hunting and trapping by local residents. The watershed serves no major populations as a water source. Archaeological potential was considered minimal. Due to the remote, pristine and subarctic/subalpine transitional nature of the area, two ecological preserves had been proposed in the area. The whole area is crown land, under the jurisdiction of the B.C. Ministry of Energy, Mines and Petroleum Resources.

The Progress Gas Development is located in the Saddle Hills, a forested upland 65 km northwest of Grande Prairie, Alberta, surrounded by agricultural lowlands. There are hundreds of oil and gas wells in the area, with exploration and development ongoing. Agricultural land uses included the cultivation of barley, oats, rapeseed and forage crops with cattle grazing occurring both on private land and on crown-owned grazing leases in the forested hill country. Most of the project area is "Green Zone" forest reserve, with Proctor and Gamble Cellulose Co. Ltd. being the major leaseholder, supplying coniferous sawtimber and pulpwood to their mills in Grande Prairie. Recreational use of the area is minor, limited to hunting and off-road vehicle use. Wildlife resources include moose and elk, and several traplines are registered in the project area. Fisheries and aquatic uses are minimal, although the hills serve as a recharge area for streams and aquifers used by several lowland towns. Archaeological potential was moderate, with a few sites having been found previously in the project area. Preservation considerations were minor, the breeding range of trumpeter swans (the nearest being 5 km away) being the only significant factor identified. The local flora and fauna are common throughout much of Alberta. All crown lands are under the jurisdiction of the Alberta Department of Energy and Natural Resources, particularly the Alberta Forest Service.

Air Photo Mapping

The selection of a suitable scale of air photographs to be used (or commissioned if no suitable ones presently exist) is a major consideration. Scales of 1:50,000 to 1:10,000 are generally suitable for terrain sensitivity mapping, the level of detail required depending much on the degree of variability in terrain properties over short distances. It is useful to conduct photo interpretation and subsequent mapping in two stages. Prior to terrain sensitivity mapping per se, it is desirable to have maps prepared at a reconnaissance level (1:25,000 to 1:50,000 scale), showing the regional features at the level of "land system", "soil order" or "forest cover" types. Such maps may already exist for the project area, may be prepared as part of a prior E.I.A., or may be done directly from air-photos prior to terrain sensitivity mapping. Mapping at this level usually depends heavily on topographic features and major differences in canopy structure (such as between marshes, shrubland and forest). These reconnaissance maps are especially useful when done on a photomosaic, providing easy reference from stereo-photos to locations and their regional context.

Following the identification of impact mechanisms, resources and regional features, an appropriate study corridor is defined. Since there were no major obstacles to the use of a shortest route corridor in the examples discussed, alternative corridors were not considered. If conflicts or obstacles did exist, one or more alternative corridors would also be mapped, inventoried and rated. Intensive study is usually confined to such corridors, generally 1 or 2 km wide, with route selection being largely limited to that of alignment within the corridor. Soil and vegetation mapping then proceeds on larger scale (1:40,000 to 1:10,000) individual stereo-pairs on which the approximate boundaries of the preliminary corridor are first drawn. Landscape interpretations may be combined depending on the degree of specialization among team members and the degree of specific emphasis that different biophysical components are to receive. For example, landform mapping is often done in conjunction with soils mapping, while vegetation mapping may include delineation of commercial forest stands.

This level of semi-detailed mapping is used for delineation of areas which are homogeneous in composition (and presumably in functional properties), and which may be expected to require similar degrees of avoidance or mitigation by the proposed project development. Soils mapping, being largely dependent on changes in topography and vegetation, may not be in traditional units such as soil series, but rather in categories pertinent to the project, e.g. based on slope, depth and expected fertility or great soil groups. Vegetation mapping likewise distinguishes plant associations (such as bogs and fens), which would behave differently in response to the impact and although different dominant canopy species may be identified, type boundaries are not necessarily shown unless the dominant growth forms and responses to disturbance are thought to be different.

For the Stikine access road, air-photo interpretation was done at only one scale (1:30,000) using monochromatic stereo-pairs. The corridor of study was one of variable width (0.5 to 4.0 km), basically covering the valley floors which defined the most direct route. Soil divisions were drawn on the basis of breaks in the landscape and parent material, with categories thus described as modified soil orders. Vegetation mapping was largely structural, distinguishing between sedge fens, sphagnum bogs, shrubland, deciduous forest, coniferous forest, and rockland or tundra. Since most of the area was shrubland, divisions within the corridor were few.

Because of the overall impact assessment needed for the Progress gas plant and its associated Saddle Hills gathering system of pipelines, 1:50,000 scale maps were first prepared for the entire region. Using a photomosaic base map, information was transferred from 1:50,000 stereo-pairs, in consultation with a number of pre-existing maps. A soil survey map showing soil series, an ecological land classification map (based on landform units) and a forest cover map all proved useful aids when information was interpreted at a general (rather than detailed) level. Following this small-scale mapping, detailed work was done on 1:15,000 scale air photos, within a 2 km wide corridor centred on the proposed pipeline route. At this level of detail, soils were mapped according to expected depth and steepness phases on different parent materials, which in turn was determined largely from geomorphology. Vegetation interpretation included distinctions among different dominant species (e.g. trembling aspen vs. balsam poplar, white spruce vs. black spruce vs. pine), and noted the degree of canopy closure.

Although understory species could not be identified from air photographs, different degrees of canopy closure would be expected to result in a different understory composition. Mapping was thus done to the level of community type, although full descriptive names could not be assigned at this time.

Field Surveying

With a full understanding of project actions and area resources, and with preliminary soil and vegetation types delineated on air photos, ground truthing and sampling can be efficiently carried out. The layout of the sampling program depends largely on the scale of the project, apparent homogeneity and access. For a small project, walking the entire corridor and doing detailed sampling (at regular intervals or whenever a new terrain type is encountered) is feasible; two or more transects within the corridor may be possible. It is always preferable to walk the whole route, but this can be more easily done when a preliminary alignment is already surveyed and is well marked. If the route is long, terrain rugged or access difficult, inspection of only a relatively few representative locations may be possible. The selection of such sites thus becomes critical, and can be assisted by air photos and by an aerial survey of the corridor by discipline specialists. The intensity of sampling depends on the variability in the study area.

Soil description and sampling procedures can make use of both soil pits and hand auger samples. Soil pits should be dug for each major type in the study area, with the identity of similar sites merely confirmed with auger digging. Soil profiles are described according to the procedures recommended by the Canada Soil Survey Committee (1978). All horizons, to a depth of about 1.0 m (or to bedrock) are to be analyzed or evaluated in the field for depth, colour, pH, effervescence, texture and stoniness. Samples of selected horizons are then collected for more detailed laboratory analysis of physical and chemical characteristics. Depending on the structural and reclamation requirements of soils for the particular project, typical laboratory analysis may include Atterberg limits, saturated moisture percentage, pH, salinity, cation exchange capacity, organic carbon or nutrient content.

Vegetation sampling is most rapidly done using the plotless relevé method, giving a Braun-Blanquet cover-abundance rating for every plant species found in a loosely defined reference area (Mueller-Dombois and Ellenberg 1974). Unknown species are pressed for later identification. If forestry considerations exist, timber volume and productivity determinations should be made, for which the use of wedge prism cruising methods are well suited. Diameter and height should be measured for all trees designated as within the plot, and an increment core of a dominant tree should be taken and the tree's age determined. Timber volumes are then determined from species-specific volume tables (available from provincial forestry offices), and mean annual increment (M.A.I.) is determined by dividing tree volume by tree age. The response of soils and vegetation to any past disturbances (fire, flooding, cutlines, etc.) should be noted.

For the Stikine project, the absence of trees throughout most of the corridor permitted a complete traverse of the route on foot. Following this descriptive reconnaissance, a number of selected sites were sampled intensively with the aid of a helicopter for transportation. A total of 13 sites were intensively sampled. Soils were generally found to be of the Brunisolic and Regosolic orders. The vegetation was dominated by willow (Salix spp.) shrubland, with subtle differences identifiable on the basis of different Salix and understory species.

Access in the Saddle Hills was much more difficult, with most of the route being in steep, dissected terrain with heavy forest cover. Although some segments of the corridor were walked, most sample sites were limited to locations that a four-wheel drive truck could reach from back roads or seismic cut-lines. A total of 96 soil sites and 63 vegetation sites were intensively sampled, including use of data from a previous (Canadian Forestry Service) study for 13 of the sites. Parent materials of soils were predominantly morainal, lacustrine and organic. The majority of soils were Luvisols,with Gleysols and Organics common in poorly drained sites. The vegetation was predominantly deciduous (Populus spp.) forest, with fire and logging obviously having played a major role in the past. Many scrub, deciduous and mixedwood successional communities were common, while mature coniferous stands (those having commercial value) were less common.

Classification

Following the collection of field observations and the compilation of sampling data, it is frequently necessary to recategorize or rename the units previously delineated on air-photos. Using the newly collected field data as an objective information source, individual sample sites (and the broad areas they represent), should be grouped according to their similarity. Criteria for soil groupings may be well defined taxonomically, whereas vegetation classes may need some sort of phytosociological tabular manipulation in order for categories to become apparent. In practice, the different soil and vegetation types can usually be ordinated along factors of moisture and disturbance. Rather than just using general similarity, project-specific criteria (such as soil erodibility or forest productivity) may be used as classification criteria. If field sampling was random and a large number of sites were described, classification can be done mathematically and impartially by means of multivariate statistical techniques (Gauch 1982). Whatever the method of classification, it is usually useful to diagram the hierarchy of classes and the whole scheme should be integrated with existing regional classifications such as maps of ecological regions (e.g. Rowe 1972, Krajina 1965).

Once the interrelationships of sampling units are clear, the degree to which these categories correspond to the preliminary air photo mapping units must be checked. The hierarchical level at which mapping was done should be identified and the mapped units should be reviewed to see that they agree with the more detailed ground level descriptions of such types. Together with general ground observations on the locations of type boundaries and properties, the survey information may indicate that some mapped units should be changed. Furthermore, additional air photo interpretation done at this stage benefits from the experience gained on the ground, so revised interpretations are likely to be better. The result should be the finalized soil and vegetation maps, transferred to a topographic or air photomosaic base. It is also a good idea to prepare tables of the dominant features of each map unit.

Soils of the Stikine Plateau were classified into their traditional Canadian System of Soil Classification soil groups, with the associated criteria for classification (namely parent material, associated landforms, slope and drainage. The vegetation of the region all fell into Rowe's (1972) Stikine Plateau Section of the Boreal Forest Region, and could be broken down further into the forest and shrubland zones of Krajina (1965). Since willow communities dominated many terrain types, it was decided that these could be usefully categorized further. Sites and species were ordinated in a phytosociological table to produce maximum clustering (Mueller-Dombois and Ellenberg 1974). The resulting classification showed the relationship of shrub community types to moisture and produced nine mappable types. The final maps were printed on a 1:25,000 topographic base.

Classification of soils in the Saddle Hills was based primarily on parent material, and secondarily by texture, drainage and slope. Identification with Canadian System of Soil Classification soil groups was also a key classificatory criterion. Soils in the project area have developed on five major parent materials:

- morainal (glacial debris);
- lacustrine (silt and clay deposits);
- fluvial (sandy deltas in glacial meltwater lakes);
- residual (bedrock); and
- organic.

Vegetation of the Saddle Hills was classified according to physiognomic or structural categories (which were mapped on the 1:50,000 regional map), associations of dominant canopy species within each structural category and community types based on dominant subcanopy species within each association. Each community was considered distinguishable on 1:50,000 air photos (although many boundaries and type names were changed from the preliminary air photo mapping) and could exhibit a different response to the proposed impacts. In preparing the final soil and vegetation maps for the Saddle Hills pipeline, a 1:20,000 photomosaic served as the base map.

Development of a Sensitivity Rating Scheme

Once the activities of inventory and mapping are complete, project personnel have a very good impression of the project area's features and how they may be affected by the (previously discussed) mechanisms of impact. Team members are now ready to devise a system of criteria for rating terrain sensitivity in a manner uniquely suited to the proposed project and the area under consideration. Critical ecological factors or sensitivity factors are identified on the basis of those impact mechanisms most likely to damage known resources. These impact mechanisms may not necessarily act only through soils or vegetation, or other resources in the area may be of more value, such that separate categories ought to be allocated for such features as wildlife or recreation. Alternatively, these concerns can be made subcategories or critical factors under a fewer number of categories (e.g. forestry concerns as a subcategory of vegetation). The system of critical factors developed for each project is usually unique, due to the particular unusual resources impact mechanisms and ecological features of a given scenario. Potential soil factors may include those such as erosion, compaction, fertility, drainage and profile reconstruction needs; vegetation factors may include those such as ecological value, timber value, critical wildlife habitat, resilience and revegetation.

Although a set of critical sensitivity factors tends of be unique to any one job, the scale used to rate the importance of these factors can be more universal. A scale of 1 to 5 can be usefully applied to most situations, although the precise meaning of each rating value must be defined for each critical factor. The general criteria for each level can be interpreted as follows:

"1" Negative impact is none or negligible (or undetectable even by scientfic investigation); designates that changes should be reversible in less than 20 years; preferred routes;

"2" Some impact probable, but effects are not major enough to require special mitigative procedures (i.e. other than those applied everywhere) other than in local (sub-unit) situations; negative changes would be apparent through scientific investigation but would generally be reversible over the course of 20 to 40 years;

"3" Significant impact will occur, and will require mitigative procedures and specific reclamation methods across the whole terrain unit; negative changes would be evident even without scientific studies, and would require 40 to 80 years to be reversed;

"4" Severe impact is likely to occur, and it would be preferrable to avoid the terrain unit rather than to implement the major mitigative methods required; negative effects would be apparent even to the untrained eye and would be reversible only over a period of 80 years or more;

"5" Impact would be catastrophic and completely unacceptable. This category is very extreme and refers to geotechnically unstable sites or destruction of legislatively protected species in danger of extinction. Negative effects would be obvious and irreversible.

Soil sensitivity factors chosen for the Stikine-Iskut cat trial route included erosion, compaction, drainage and topography. Soil erosion by water was considered a major danger to be avoided because of its accelerating and cumulative effect on the terrain once started. Once soil material is lost, its ability to support plants is reduced, and with less protective plant cover, erosion will become even worse. Erosion danger was assessed using qualitative assessment of factors in the Universal Soil Loss Equation (Wischmeier and Myer 1973), namely rainfall intensity and length (generally uniform across a project area), slope length and slope gradient, soil type (especially depth, texture and cohesiveness) and vegetative cover and the extent of its probable removal. Compaction was considered a potential problem because of decreased porosity and water infiltration and increased bulk density that could deter root penetration, soil moisture availability and plant growth. In assessing compaction sensitivity, consideration was given to soil bulk density, organic matter content, silt and clay content, coarse fragment content and moisture content. Organic matter helps maintain structure and decreases compactibility, high silt and clay contents indicate greater compactibility, while coarse rock fragments hinder compaction; compaction is greatest when moisture content is slightly below the plastic limit. To account for low bearing strength during summer, poorly drained areas were assessed, generally using the assessments of drainage recommended by the Canadian System of Soil Classification. The literature was consulted to determine the safe bearing strength of different soils under wet and dry conditions. Topographic limitations were also considered under the soil assessment, since no separate geomorphological assessment was done. Slope steepness and complexity were the major components of topographic limitation. The banks of creeks, slopes of eskers and scarp outcrops of bedrock were the major topographic feature limitations not already dealt with under drainage or erosion.

Vegetation sensitivity factors chosen for the Stikine route included ecological value and resilience. Ecological value was rated according to the presence of rare or endangered plant species, plant community associations unusual to the region and (in the absence of a separate wildlife assessment), critical wildlife habitat. Species rarity included range extensions, unusual hybrids and species potentially new to science. Vegetation resilience refers to the ability of the plant community to withstand disturbances in general, and to rapidly regenerate following disturbance. The general criteria for evaluating resilience include canopy compressibility, the potential for vegetative resprouting, the ability of the vegetation type to rapidly reseed itself to some sort of plant cover, and the time anticipated for the community to regenerate to its predisturbance condition.

For the Progress Gas Development, soil factors of erosion, compaction and reclamation requirements were chosen. Criteria for the rating of erodibility were similar to those used for Stikine, with the presence of well developed Ae, Ah or Ap horizons also being indicative of serious fertility losses that would result with the erosion of topsoil. Slope classes were modified from the Canada System of Soil Classification (1978) to provide explicit criteria for erosion sensitivity (Table 1). Compaction ratings were devised to include drainage considerations, because compaction is considered a significant limitation on soils with sub-hydric and hydric moisture regimes (imperfectly to very poorly drained). Compaction may also occur when soil moisture contents are high after periods of heavy rainfall or during thawing. Criteria for compactibility therefore included drainage (primarily), organic matter content, soil texture and coarse fragment content. The final soil sensitivity factor of reclamation potential is related to soil properties which are indicative of soil productivity or the potential to support rapid, successful revegetation. In effect, it relates soil morphology to reclamation procedures (specifically, materials handling) needed to maintain a suitable plant growth medium at the surface.

Factors chosen to assess vegetation sensitivity in the Saddle Hills included ecological value, existing timber value, potential timber value, resilience or susceptibility to adjacent disturbance, and probable revegetation problems. Ecological value considerations included rare species, critical wildlife habitat, and the presence of climax forest types (which represent a relatively unusual community type in the region). Existing and potential timber values received major assessment because of the importance of the resource and of alternative forestry land uses in the area. In terms of existing timber standing crop, ratings were based directly on the proportion of mature, large-stature conifers (suitable for saw timber) found in the district. Potential timber value was given a separate assessment because timber salvage prior to pipeline construction would not prevent loss of the resource. This rating was based on the proportion of juvenile conifers in the stand, and soil and drainage conditions indicative of the ability to support good tree growth. Unlike the Stikine project, pipeline development usually includes complete removal of vegetation in the corridor. The resilience of that vegetation is therefore of little relevance, since it will all be removed except at sites with no trees or shrubs (such as sedge marshes, where development may proceed without vegetation removal). While the re-establishment of vegetation in the corridor was considered under the vegetation assessment, the resilience of the adjacent vegetation should also be considered. The ecological amplitude of the dominant species of a community was considered relative to the expected impacts of adjacent canopy removal or disrupted drainage. Revegetation rating criteria were based on anticipated problems at rocky or steep locations, and in areas with high water tables and organic soils. This revegetation rating is distinct from the soils reclamation factor in that it is based solely on anticipated plant growth and options of revegetation species selection, rather than on the need for selective soil materials handling.

TABLE 1

Fluvial Soil Characteristics
Progress Gas Development

Characteristic		Soil Type		
		FF	FD	FJ
Soil Classification		**Orthic Luvic Gleysol**	**Cumulic Humic Regosol**	**Orthic Eutric Brunisol**
Drainage		Imperfect to poor	Imperfect to poor	Good to moderately good
Slope:	%	0–5	0–5	2–15
	Position	Mid to lower	Mid to lower	Mid
pH Horizon:	A	4.5 to 5.0	5.1 to 6.0	6.1 to 6.5
	B	4.5 to 5.0	5.1 to 7.3	6.1 to 6.5
	C	4.5 to 6.5	5.1 to 7.3	6.1 to 6.5
Texture*	A	SivfS to SiL	LS to L	LS
	B	SL to C	CL to C	SL
Perviousness	B	Moderate	Moderate	Rapid
	C	Moderate	Moderate	Rapid
Depth to C horizon (cm)		18–61	13–35	68

* C = Clay, L = Loam, S = Sand, Si = Silt, vf = very fine

It is important to develop specific and explicit criteria for the application of the rating scale to each soil and vegetation factor. Tables 2 and 3 illustrate the exposition of such criteria for soils and vegetation respectively, as applied to the Progress Gas Development.

Application of Sensitivity Ratings

Once the key sensitivity factors and criteria for their rating have been devised, one can return to the tables summarizing the salient features of each soil and vegetation type, and assess its expected sensitivity to each factor. If the data collected are complete, and if the rating criteria are explicit, this procedure should be easy to carry out. If the characteristics of a particular type are too ambiguous to assign it a sensitivity value, then the rating criteria may have to be changed or additional field information may be needed. Despite clear criteria for rating application, this process involves a degree of subjectivity. Additional sources of information to be drawn upon in assigning sensitivity values include published literature and past experience regarding the behaviour of similar soils and vegetation in response to similar disturbances, the recovery progress evident from earlier disturbance scars observed in the area, and a degree of speculation or extrapolation about the mechanisms of impact at any particular season. The results should be repeatable by other competent environmental scientists, and the accuracy of the assessments improves with experience.

The sensitivity of each map unit to each factor should be tabulated for future reference. The most critical or limiting factors are then noted, and they are then portrayed on the maps as the basis for route selection. A useful notation includes the sensitivity class and the limiting factors, such as "3et" (having Class 3 sensitivity due to ecological and timber values). It would be advantageous to show the rating for each factor shown on the map, but this generally results in overly crowded map symbols. The terrain sensitivity maps must be viewed only as a selective summary of information ratings primarily serving the purpose of route selection. For the purpose of determining site-specific mitigation and reclamation procedures, reference must be made back to the various summary tables that describe the actual features of each map unit.

The only Stikine soils to receive high erodibility ratings were localized sites (creek banks and an esker wall) with very steep slopes, and Orthic Regosols with shallow bedrock. Only two soil types were rated as sensitive to compaction: a sandy south-facing slope and thin Regosol soils overlying bedrock. Three soil types showed definitive characteristics of poor drainage: a Gleyed Humic Regosol and two Typic Mesisols (organics). Topographic limitations (steep slopes and rock outcrops) were limited to a creek bank, esker wall and a large Regosolic area with local rock outcrops. High ecological values were assigned to bogs dominated by feathermoss, and to xeric subalpine shrublands having several species rare in the region. A very high ecological value was also ascribed to a diverse deciduous woodland which contained an unusual range extension, a potentially unknown Gentian species, and rare Populus balsamifera x tremuloides hybrids. Poor resilience was noted for a number of communities, including all those with tree species, steep slopes and

TABLE 2

Soil Sensitivity Classes
Progress Gas Development

Sensitivity Class	Rating Characteristics		
	Erosion Sensitivity (e)	Compaction Sensitivity (c)	Reclamation Sensitivity (s)
1 (least sensitive)	Soil types FD, FF, LA, LG, LB, OD, ML. Slope 0-2%. Level ground, little erosion potential.	Soil types MA, MB, ME, MH, RA, RH, FJ, RE, LA, LG. Well drained soils. Little compaction sensitivity.	All soil types except those below. No expected reclamation problems.
2	Soil types FJ, OC, ME, MH, MJ. Slope 2-15%. Moderate slopes.	Soil types MJ, ML, MM, LB, FD, FF. Poorly drained soils.	Soil types RA, RE, RH, FJ. Shallow profiles with little soil development.
3	Soil types MA, MM. Slope 10-20%. Moderately steep slopes.	Peaty soils. Generally wet, organic veneer.	Soil types LA, LG, LB, MM, OC, OD, peaty phases. Potential salt problems or drainage problems.
4 (highest sensitivity in area)	Soil types MB, RA, RH. Slope 30%. Steep terrain, high erosion potential.	Soil types OC, OD. Very wet areas, fens and bogs. Highly sensitive tc compaction.	Not applicable in Progress area.

TABLE 3

Vegetation Sensitivity Criteria
Progress Gas Development

Sensitivity Class	Rating Characteristics			
	Ecological Value (e)	Timber Value (t)	Resilience to Disturbance (d)	Revegetation Potential (r)
1 (least sensitive)	Common species and communities	No suitable timber	Scrub or upland forest with diverse and robust species	No potential problems
2	Uncommon species and communities; valuable wildlife habitat	Scattered conifers or sizes suitable only for posts, roundwood or pulping	Species sensitive to dusting, canopy opening; extensive litter which is susceptible to fire; wetlands sensitive to water level fluctuations	Poorly drained sites requiring higher seeding rates
3	Rare or endangered species and communities; critical wildlife habitat	Merchantable trees of sawlog dimensions	Communities susceptible to water level changes	Organic soils with high water table where revegetation is difficult
4 (highest sensitivity in area)	Species, communities or wildlife habitat requiring special attention	Mature merchantable trees in pure stands	Communities extremely sensitive to adjacent vegetation removal or soil alteration	Severe sites with extreme soil, water or slope characteristics

poor drainage (where churning or rutting would occur).

In the Saddle Hills, the inherent erodibility of most soils ranges from moderate to high. High ratings were assigned for various steep-sloped sites (notably creek banks), some Luvisols with a well developed Ae horizon, and some Mesisols and Luvisols with marked Ah or Ap horizons. Very high compaction was predicted for the organic soils of fens and bogs, with moderate to serious effects expected for other poorly drained soils and peaty phases. Reclamation needs were rated the highest on agricultural lands, where the restoration of topsoil horizons is of special importance to the maintenance of productivity. The most sensitive soils were those in lacustrine lowlands, humic Gleysols on forested land, and organic soils of discharge areas.

Vegetation sensitivity ratings for the Saddle Hills area are summarized in Table 4, and can be assessed relative to the community composition, timber volumes and productivities. No communities received high ecological values, but two communities had a moderate ("2") ecological sensitivity: an Aspen-White Spruce/Rose community because it is the habitat for the round-leaved orchid (Habenaria orbiculata), considered uncommon or rare in Alberta; and White Spruce/Rose stands because such types approximate the regional climax vegetation and such mature stands are infrequent in the area. About half of all community types received Class 1 timber ratings, having no conifers present. Class 2 timber ratings were assigned to black spruce and tamarack communities, and to riparian sites where large trees are widely scattered. Many sites received Class 3 ratings, having dense stands of large white spruce or pine; only the White Spruce/Rose type received a rating of Class 4. In terms of potential timber value, poorly drained sites and those with dense shrub canopies were rated as Class 1. Most of the deciduous, mixedwood and coniferous stands received ratings of Class 2, while various sites with a large component of young white spruce or pine in the understory, or yet to mature, were rated Class 3. Only an Aspen-White Spruce/Rose community, with a subdominant white spruce canopy that could be harvested in about 20 years, received a rating of Class 4. Most community types have some susceptibility to adjacent disturbances, especially through canopy opening and disrupted drainage, and hence were assigned Class 2 ratings. Class 1 ratings were given to scrub, poplar and birch associations, all of which are well known for their wide ecological amplitude and tolerances. Sphagnum bog communities were rated Class 3 because of their close dependence on stable water levels. Revegetation problems may arise on steep sites, such as stream banks occupied by riparian communities. Such sites were rated as Class 2, as were fen communities (sedge-dominated), which have high water tables and organic soils. Class 3 ratings were given to bogs and fens with deep organic layers and where water is always present. The successful revegetation of such sites will depend on selection of water-tolerant species and a certain amount of regrowth or re-invasion by the existing sedges, reedgrasses, birches, willows, and ericaceous shrubs.

Map Overlays

Separate soil and vegetation maps prepared at the same scale (and usually on the basis of the same air photographs) have by this stage been prepared. The sensitivity rating for each map unit has been determined and is portrayed

TABLE 4

Summary of Vegetation Sensitivity Ratings
Progress Gas Development

Plant Community	Sensitivity Factors				
	Ecological Value (e)	Timber Value (t)	Resilience to Disturbance (d)	Revegetation Potential (r)	Limiting Factor
Marsh Reedgrass	1	1	1	1	1
Sedge	1	1	2	2	2 d r
Dwarf Birch/Sedge	1	1	2	2	2 d r
Willow-Birch/Reedgrass	1	1	1	1	1
Willow-Alder/Reedgrass	1	1	1	1	1
Willow/Feathermoss	1	1	1	3	3 r
Poplar-Spruce-Birch/Willow	1	2	2	2	2 tdr
Clearcuts:Willow-Alder/Conifers	1	1	1	1	1
Burns:Willow-Alder/Fireweed	1	1	1	1	1
Paper Birch/Alder-Willow	1	1	1	1	1
Poplar/Sarsparilla	1	1	2	1	2 d
Poplar/Alder-Willow	1	1	1	1	1
Aspen/Rose	1	1	1	1	1
Aspen/Alder-Willow	1	1	1	1	1
Paper Birch-White Spruce/ Horsetail	1	3	2	1	3 t
Poplar-White Spruce/ Bunchberry	1	3	2	1	3 t
Aspen-White Spruce/Rose	2	3	2	1	3 t
Aspen-Pine/Buffaloberry	1	3	2	1	3 t
White Spruce/Alder-Willow	1	3	2	1	3 t
White Spruce/Rose	2	4	3	1	4 t
Pine-White Spruce/Bunchberry	1	3	3	1	3 t d
Pine/Alder	1	3	2	1	3 t
Pine/Cranberry	1	3	3	1	3 t d
Tamarack-Black Spruce/ Labrador Tea	1	2	3	3	3 d r
Black Spruce/Sphagnum	1	2	3	3	3 d r

either on the map or is listed in auxiliary tables which summarize map unit traits. The next step is the combining of soils and vegetation information to create a terrain sensitivity map. This process can be done manually using transparent overlay maps (Wooley and Passey 1980), or automatically if the line drawings (soil and vegetation maps) have been digitized on computer (Newkirk 1979, Rasmussen _et al_. 1980). Whatever the method of transfer, a certain amount of interpretation and judgement is still required in defining final terrain units. It is useful to have a high quality photomosaic as a base map during this process, to allow some reference back to the original landscape. Many boundaries of soils and vegetation units will coincide, since much undisturbed vegetation has developed in response to soil factors, or in response to the same topographic factors that the soils have. Boundaries which are a few millimeters apart on the map but follow similarly shaped paths were probably devised on the basis of the same feature (which can be confirmed from the photomosaic) and should be denoted by only one line. Other boundaries will be quite independent of each other, and a distinct soil or vegetation border is now traced to delimit a separate terrain unit. Each terrain unit may thus denote only slight differences from its neighbour in terms of either soils or vegetation, but not necessarily both. These "terrain units" therefore should not be confused with the "land systems" or "land types" of ecological land classification schemes (e.g. Lacate 1969), since they do not refer to an area of land on a particular parent material or landform which has a homogeneous combination of soils and chronosequence of vegetation. That is, soils may vary from one terrain unit to the next while vegetation may not, or _vice versa_. Several vegetation types corresponding to different seral stages (e.g. shrubland, mixedwood forest, coniferous forest) may occur on one soil type because of the local history of disturbances. This is especially true for much of Canada's forest lands, where the existing vegetation is so much a function of the local history of wildfires, insect infestations or logging. The terrain map is thus a summary of the traits of existing features, not potential features. Furthermore, since its primary purpose is that of aiding route selection, map units having identical sensitivities can be combined. An Aspen-White Spruce/Alder community on a Eutric Brunisol may thus be combined on the final map with a Balsam Poplar/Rose community on a Gleyed Luvisol, should they both have identical sensitivity ratings and limitations. The final map units are each denoted by their soil and vegetation sensitivities, with the soils rating over the vegetation rating:

e.g. $\frac{3e}{2dt}$ - soil sensitivity Class 3, limited by erodibility
- vegetation sensitivity Class 2, limited by resilience to disturbance, and by timber value

It is useful to colour-code the map units, based in their highest sensitivity rating. This aids in the route selection process, in that units with the same colour should be avoided to the same degree, although their specific limitations may differ.

Figures 1 to 3 show examples of the computerized overlay process, using maps devised for the Progress Gas Development. Figure 1 is the soils map for a segment of the pipeline corridor, the map units described in terms of landform, parent material, slope, solum thickness, drainage and soil group. Figure 2 is the corresponding vegetation map for the same area, with

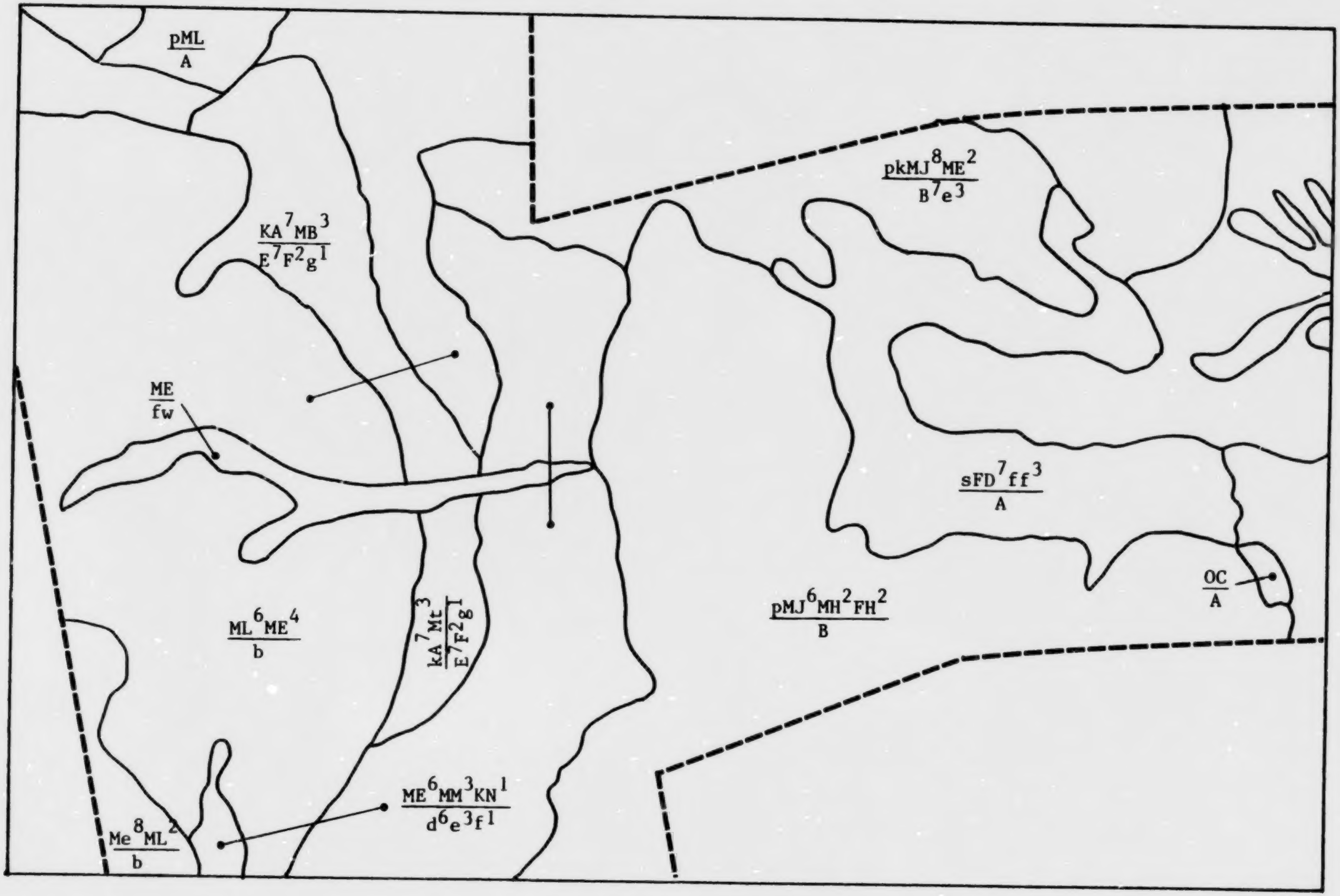

$\frac{pML}{A}$
$\frac{KA^{7}MB^{3}}{E^{7}F^{2}g^{1}}$
$\frac{pkMJ^{8}ME^{2}}{B^{7}e^{3}}$
$\frac{ME}{fw}$
$\frac{sFD^{7}ff^{3}}{A}$
$\frac{OC}{A}$
$\frac{ML^{6}ME^{4}}{b}$
$\frac{kA^{7}Mt^{3}}{E^{7}F^{2}g^{1}}$
$\frac{pMJ^{6}MH^{2}FH^{2}}{B}$
$\frac{ME^{6}MM^{3}KN^{1}}{d^{6}e^{3}f^{1}}$
$\frac{Me^{8}ML^{2}}{b}$

Figure 1. Soils Map for Part of the Progress Gas Pipeline

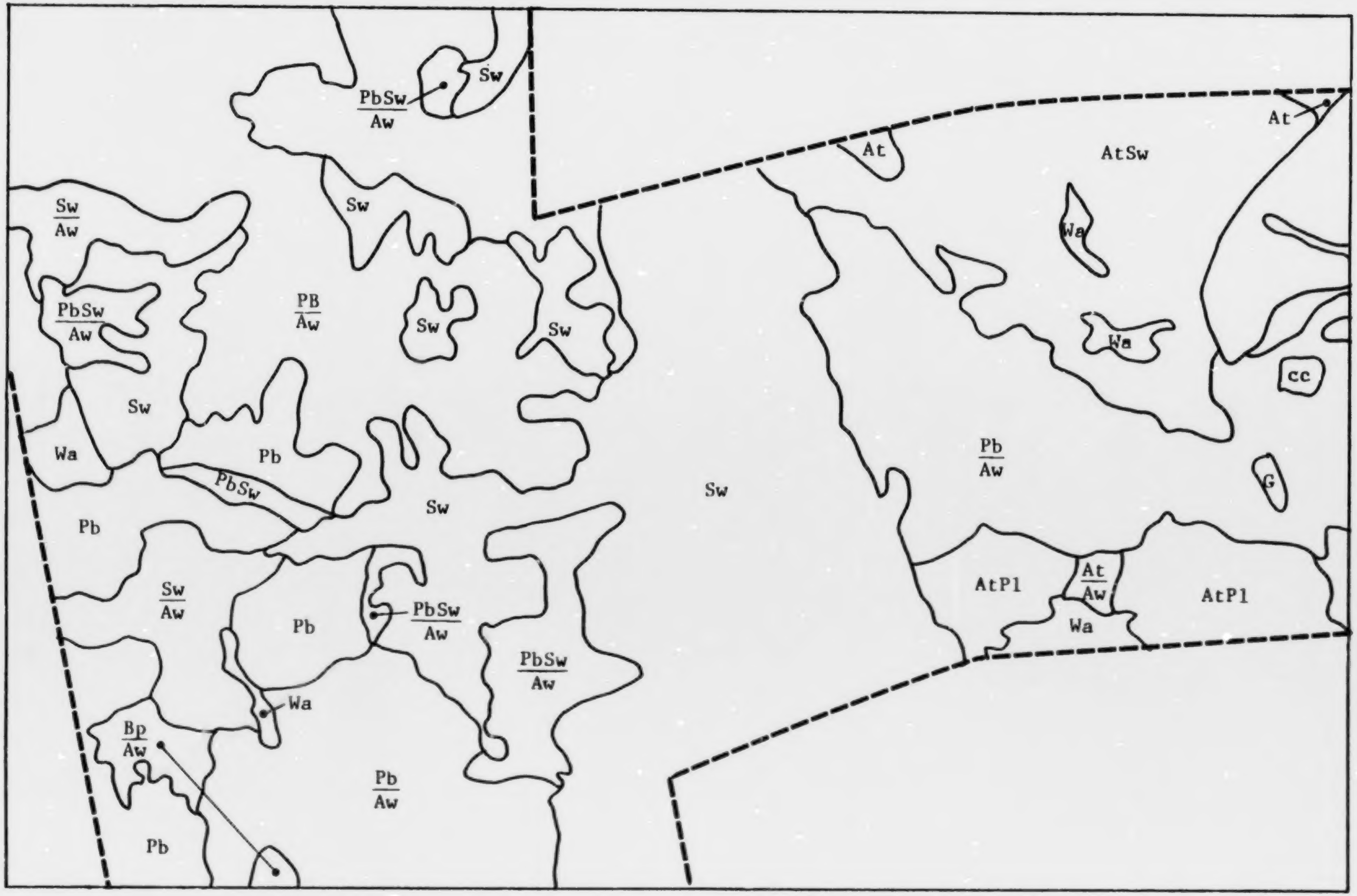
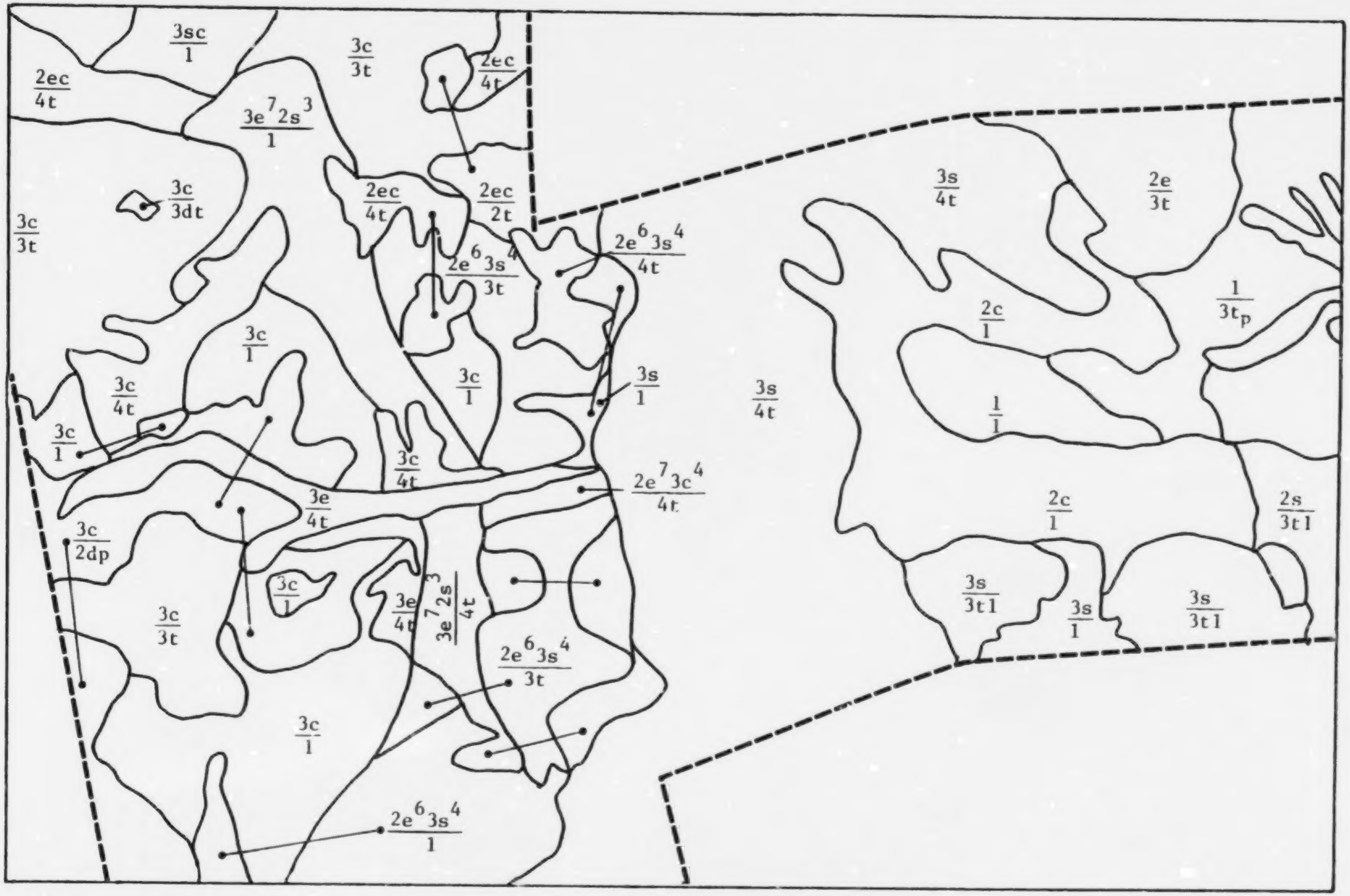

PbSw/Aw
Sw
At
AtSw
At
Sw/Aw
Sw
Wa
PbSw/Aw
PB/Aw
Sw
Sw
Wa
cc
Sw
Wa
Pb
Pb/Aw
PbSw
Sw
Sw
G
Pb
AtPl
At/Aw
AtPl
Sw/Aw
Pb
PbSw/Aw
Wa
PbSw/Aw
Wa
Bp/Aw
Pb/Aw
Pb

Figure 2. Vegetation Map for Part of the Progress Gas Pipeline


$\frac{2ec}{4t}$
$\frac{3sc}{1}$
$\frac{3c}{3t}$
$\frac{2ec}{4t}$
$\frac{3e^7 2s^3}{1}$
$\frac{3c}{3dt}$
$\frac{3c}{3t}$
$\frac{2ec}{4t}$
$\frac{2ec}{2t}$
$\frac{2e^6 3s^4}{3t}$
$\frac{2e^6 3s^4}{4t}$
$\frac{3c}{1}$
$\frac{3c}{4t}$
$\frac{3c}{1}$
$\frac{3c}{1}$
$\frac{3s}{1}$
$\frac{3c}{4t}$
$\frac{3e}{4t}$
$\frac{2e^7 3c^4}{4t}$
$\frac{3c}{2dp}$
$\frac{3c}{1}$
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$\frac{2e}{3t}$
$\frac{2c}{1}$
$\frac{1}{3t_p}$
$\frac{1}{1}$
$\frac{2c}{1}$
$\frac{2s}{3t1}$
$\frac{3s}{3t1}$
$\frac{3s}{1}$
$\frac{3s}{3t1}$

Figure 3. Terrain Sensitivity Map for Part of the Progress Gas Pipeline

descriptions of forest cover, canopy closure and understory structure that correspond to the plant communities sampled and described earlier. Each map was digitized on a Computer Aided Drafting (CAD) station, and a combined ("overlay") map then produced. Final terrain boundaries were confirmed manually, sensitivity ratings were added and the final terrain sensitivity map (Figure 3) was printed on a photomosaic base map. This final map is a summary of differential impact susceptibility and provided the basis for final route (alignment) selection and mitigation planning.

Route Selection

Environmentally sound route selection is one of the reasons for preparing a terrain sensitivity map on the first place. The overall acceptability of a project may have been affirmed already, or this approval may depend on the particular alignment selected. In either case, a credible route selection process must consider a wide enough corridor (or a number of corridors) to provide some reasonable alternatives. The general approach is to follow "the path of least resistance" (shortest distance, most level topography), subject to constraints of geotechnical and ecological stability; other constraints may be imposed according to the construction methods or operational requirements of a particular development.

In practice, therefore, the most straightforward route (generally chosen by project engineers) is followed unless map units having high sensitivity ratings are encountered. Class 5 lands (being exceedingly sensitive and rarely encountered) cannot be crossed at all, while the use of Class 4 lands would require complex mitigation methods that would be better to avoid if at all possible. Class 3 areas are generally passable if the mitigation and reclamation procedures are carefully followed, whereas Class 2 lands can be crossed with only a few localized concerns. Class 1 lands, when they exist, provide the most desirable route, to be used whenever possible. The key is to traverse the terrain between any two fixed points in a manner that provides the best compromise between expediency and environmental concerns. This process of selecting the final route alignment can be a long drawn-out activity involving project engineers and environmental advisors. It can be done solely on the basis of the terrain sensitivity map, but it is best done in conjunction with a final aerial inspection of the corridor to confirm map unit boundaries and interpretations. Thus minor changes in interpretation can be incorporated at the same time that first-hand observation and the portrayal of previously collected data are used together to choose an optimal alignment.

The final route recommended for the Stikine-Iskut cat trail was based primarily on keeping to deep well drained soils that were level and free of forest cover. Deep organic deposits were avoided where possible, given the above constraints; steep slopes have to be negotiated only at stream crossings. Most of the route follows Class 3 lands, indicating that any summer access would require great care and reclamation effort. The only feature to be carefully avoided was an esker with steep sandy slopes and a unique vegetative cover.

The pipeline route decided upon for the Progress Gas development was aligned primarily on the basis of using existing cutlines and clearings, with greater emphasis placed on the mitigation and reclamation procedures needed to permit use of "straight-line" routing wherever possible. Alterations from the shortest possible route were implemented to take advantage of lands previously cleared by agriculture, logging or exploration, and to improve approaches to stream crossings. Most of the terrain traversed was rated Class 2 or 3, with very detailed reclamation procedures developed for agricultural and organic soils, and for steep slopes. Distances through organic soils and valuable timber stands were nevertheless minimized whenever possible. No natural features were deemed non-passable. As a result, the terrain-sensitivity map developed for the Progress Gas Development was used more for the purpose of directing site-specific reclamation planning than for route selection. Although well sites were already fixed, the final site chosen for the gas processing plant was selected to avoid poorly drained soils and mature timber stands.

Mitigation and Reclamation Planning

Terrain sensitivity ratings, derived in the manner described in the previous sections, denote several related properties of a landscape unit: its value as a forestry, agricultural, or ecological resource; its susceptibility to damage of a proposed development action; and its ability to recover following the disturbance. Ultimate interpretation of these ratings is in terms of which landscape units to avoid, and which particular concerns must be addressed in those areas disturbed. For this latter process of mitigative planning, the terrain sensitivity map and its ratings provide only a summary of the most critical factors in each landscape unit and the level of attention that must be paid to them. To prepare a detailed environmental protection plan, reference must be made back to the original biophysical descriptions, and additional field observations may be required to overcome potential problems which are site-specific or were unanticipated. This whole process of preparing a development and reclamation plan can be quite involved and is worthy of being detailed in a separate paper. It results in a document of such a level of detail and quantification that it can be used directly by construction contractors.

In preparing an environmental protection plan, each type of terrain unit (with its distinctive soil and vegetation sensitivity ratings) is assessed for its particular needs to minimize impact. Since the sensitivity classes portrayed on the map only show the most severe or limiting factors, reference must be made back to the complete sensitivity rating summaries (such as Tables 3 and 4). Means of minimizing impact may include the timing of activities, specification of acceptable machinery, materials handling procedures, installation of erosion control and drainage structures, timber salvage, debris disposal, revegetation species mixtures and application rates, and fertilizer blends and application rates. Other protection mechanisms may be implemented if different specific sensitivities had been identified. Some procedures may be devised for broad classes of sites: e.g. drainage sensitivities of 3 or 4 are to be reseeded to a water-tolerant species mixture, erosion sensitivities of 3 or 4 are to be reseeded to a rapid establishing species mixture, while all other ratings are to receive a general purpose mixture. Other procedures require detailed assessment of the biophysical data for each site: e.g. erosion control specifications are devised according to the particular slope steepness, slope length, soil structure, soil depth and parent material of a site, even though sites which vary in these traits may have the same level of erosion sensitivity. Special procedures may be required at particular locations (such as a stream crossing), in which case specifications may be drawn up for one instance rather that for an entire terrain type. The segment of corridor to which each treatment is to be applied must be designated, either by reference to the terrain sensitivity units, or on a separate map.

Mitigative measures recommended for the Stikine-Iskut cat trail concentrated on the desirability of using only winter access. Since the route was selected to avoid forested areas, most of the route would have very low sensitivity and reclamation requirements if equipment were moved only under conditions of frozen soils and a thick snow pack. In the event that access was carried out in the summer, specifications were made for seed and fertilizer mixtures to be used in reclaiming certain terrain units. Individual specifications (regarding approach, excavation, topsoil salvage and replacement, and erosion control) were devised for each stream crossing, and it was suggested that impact on organic terrain would be minimized by multiple trailing. A reconnaisance monitoring program was recommended for a few years after trail abandonment.

Environmental protection specifications for the Progress Gas Development were much more detailed, and concentrated on the segment by segment needs for pipeline installation. Figure 4 is an example of the presentation format used for showing these recommendations and the areas to which they should be applied. The merits of using winter construction for this project were also emphasized, but the recommendations are to be followed no matter what season is used. A general set of procedures was recommended for most areas where soil and vegetation sensitivities were rated as "2" or less. These areas were mostly moderately well drained upland areas supporting deciduous or mixedwood forest. Normal materials handling procedures are to include only the salvage of the thin litter and topsoil layers, to be replaced at the surface after pipeline installation. Erosion control, drainage control and timber salvage are not required for these areas. Forest debris is to be disposed of in windrows by burning. For revegetation, the surface is to be prepared with a breaking disc, and a general purpose seed mixture (alsike clover, timothy, creeping red fescue and crested wheatgrass) is to be seeded with a 57-23-60 fertilizer blend. At other areas with higher sensitivities, specific measures were recommended for dealing with shallow organic soils, deep organic soils, agricultural land, stream crossings, poor drainage, various erosion hazards, and for the salvage of merchantable coniferous timber. Much site-specific planning went into devising these recommendations, often based on quantitative objectives and assessments.

For example, erosion control measures were devised on the basis of disrupting slope length and increasing protective cover so that erosion losses predicted by the Universal Soil Loss Equation (Wischmier and Myer 1973) would be less than 17.8 t/ha. Similarly, site-specific revegetation seed mixtures and rates were devised to provide a given density of plant seedlings (about

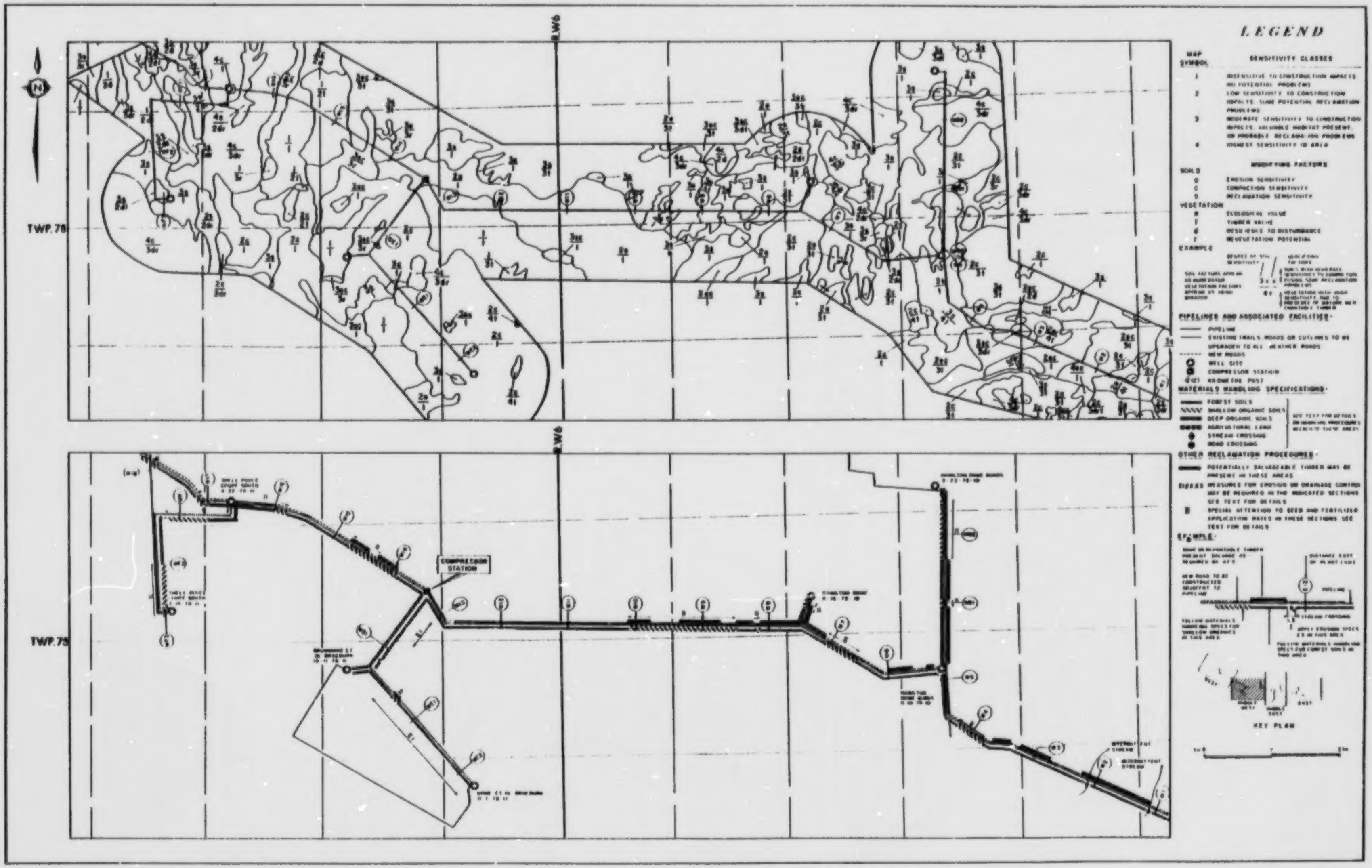
LEGEND
MAP SYMBOL
SENSITIVITY CLASSES
1 INSENSITIVE TO CONSTRUCTION IMPACTS NO POTENTIAL PROBLEMS
2 LOW SENSITIVITY TO CONSTRUCTION IMPACTS, SOME POTENTIAL RECLAMATION PROBLEMS
3 MODERATE SENSITIVITY TO CONSTRUCTION IMPACTS, VALUABLE HABITAT PRESENT, OR PROBABLE RECLAMATION PROBLEMS
4 HIGHEST SENSITIVITY IN AREA
MODIFYING FACTORS
SOILS
e EROSION SENSITIVITY
c COMPACTION SENSITIVITY
s RECLAMATION SENSITIVITY
VEGETATION
ECOLOGICAL VALUE
TIMBER VALUE
RESILIENCE TO DISTURBANCE
REVEGETATION POTENTIAL
EXAMPLE
PIPELINES AND ASSOCIATED FACILITIES:
PIPELINE
EXISTING TRAILS, ROADS OR CUTLINES TO BE UPGRADED TO ALL WEATHER ROADS
NEW ROADS
WELL SITE
COMPRESSOR STATION
KILOMETRE POST
MATERIALS HANDLING SPECIFICATIONS:
FOREST SOILS
SHALLOW ORGANIC SOILS
DEEP ORGANIC SOILS
AGRICULTURAL LAND
STREAM CROSSING
ROAD CROSSING
OTHER RECLAMATION PROCEDURES:
POTENTIALLY SALVAGEABLE TIMBER MAY BE PRESENT IN THESE AREAS
MEASURES FOR EROSION OR DRAINAGE CONTROL MAY BE REQUIRED IN THE INDICATED SECTIONS SEE TEXT FOR DETAILS
SPECIAL ATTENTION TO SEED AND FERTILIZER APPLICATION RATES IN THESE SECTIONS SEE TEXT FOR DETAILS
EXAMPLE:
PIPELINE
STREAM CROSSING
KEY PLAN
R.W6
TWP.78
TWP.78
COMPRESSOR STATION

Figure 4. Terrain Sensitivity and Environmental Protection Specifications for Part of the Progress Gas Development.

250 per m^2), based on expected obstacles to germination and broadly known properties of moisture tolerance and rate of cover buildup characteristic of the individual species. These particular procedures are then shown schematically on a map of the pipeline route (Figure 4), with full specifications being indexed in tabular form.

The final component of the environmental protection plan was recommendation of a comprehensive monitoring program to be carried out at regular intervals, especially in those areas which had high sensitivities. Such a program is designed to check for unacceptable erosion, poor revegetation or any deterioration of the associated landscape. In this manner, poorly reclaimed areas can be patched up as needed, and a feedback mechanism is provided for improving future sensitive assessments and protective recommendations. The final result can then be a well vegetated corridor with a uniformly dense plant cover.

CONCLUSIONS

The rating of terrain sensitivity can play a useful and central role in environmental planning. By selective collection of data relevant to the anticipated actions of a proposed development, and by defining map units with similar ecological properties, terrain sensitivity assessment can provide a much more focussed approach to environmental impact assessment and to development and reclamation planning. Although issues such as the reliability of using ecosystem structure to infer specific ecosystems processes and responses remain unresolved, it is clear that any systematic attempt at recognizing the differential impact susceptibility of a landscape can only lead to improve understanding and planning. If these different ecological properties are left unaccounted for, gross oversimplifications will be made regarding anticipated impact and mitigative needs.

Major strengths of the rating approach outlined above are that it is explicit and easily followed, and it can be easily modified (according to disturbance mechanisms and existing environmental concerns) to be project-specific for any number of proposed developments. Furthermore, the results are easily presented in a visual form, and they can be readily appreciated and followed by project engineers. Recommendations for routing and for reclamation procedures are a logical extension of the sensitivity ratings, and are often related to features that a civil or forestry engineer would also consider.

This process will undoubtably be improved with successive applications. Future directions will include enhanced remote sensing interpretations, parametric mapping, and computer database management, mapping and modelling. There are many opportunities for improving the objectivity, quantification and reliability of descriptions, map units and assessments.

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Climate Concerns in Offshore Hydrocarbon-Related Siting and Routing Decisions

1. Introduction

Since the 1960's and the first large rush by private industry to acquire oil and gas leases for promising acreage in the Canadian Arctic offshore, interest in the hydrocarbon potential of both the North and the Atlantic and Pacific offshore areas of Canada has remained high. The lease requirements to spend certain minimum amounts of money to investigate this potential have meant that many millions of dollars have been invested in these areas. Not only have many exploration wells been drilled with a number of oil and gas discoveries resulting, but also high levels of expertise in offshore engineering, knowledge of offshore environmental conditions and understanding of the interaction between the two have been developed. This is certainly true in the area of climate. The learning process has benefited both industry and government - the former in regard to the amount, type and applicability of the offshore climate data that are available (or not, as the case may be), and the latter concerning the specific climate and related needs of the offshore industry.

2. Climatic Elements

2.1 General

The interests of the offshore hydrocarbon industry encompass a wide range of activities: geophysical surveys, design and operation of fixed and dynamically positioned exploration and production platforms, airborne logistic support, sea-bed and overland pipelines, siting and construction of liquifaction plants and port facilities, design and routing of marine transportation, and possible oil-spill movement, containment and clean-up. Such a range of interests means that nearly every element of climate needs to be considered in one phase or another of any offshore operation. Nevertheless, there are certain elements which are of particular concern.

Wind, both direction and speed, is the most important climate element particularly for the roles it plays with other climate and related elements. For example, wind interacts with water currents in the movement of sea ice and oil spills, with sea ice in wave generation, with air temperature in wind chill and air quality, with air and sea surface temperature in structural icing and with cloud and visibility in determining flight limits. In itself, wind has important impacts for the design of exploration platforms in respect to the siting of flaring, cargo handling, the helideck, module access and general deck layout so that optimum relative positioning can be determined. Wind is also important for the redistribution of snow cover which is significant to winter pipeline construction on land. With such a wide range of influences, it is clear that wind impacts on every phase of offshore and related operations.

In addition to its interaction with wind, temperature of the air (and of the sea surface and sea bed) is important for the selection of materials for adequate structural design. Low air temperature is a concern for the development of ice fog near water vapour sources such as pipeline pumping stations. Sea-bed temperatures affect the viscosity of crude oil and low temperatures can precipitate its wave content causing pipelines to clog (Haskins, 1981). Air temperature, of course, is the primary factor in the development and thickness of sea-ice.

The fundamental design criteria for offshore drilling platforms require wave height and period information, particularly the largest wave that may be expected in a 50-100 year period. Increasingly, however, there is interest in smaller waves which may continue over long periods of time and contribute to accelerated structural fatigue problems. The direction of wave patterns is also of concern since savings of 5 percent or more of the quantity of steel used can be made by placing a suitably designed platform in the optimum direction (Gaskell, 1979). Wave generation which is basically a function of wind and its duration, geography and water depth may be further complicated by the presence of sea ice. This tends to reduce the available areas of open water over which waves may be generated (fetches) and in itself acts as a damper on wave actions in the vicinity of ice edges.

Structural icing due to freezing spray which is a function of wind speed, air and sea temperature, and wave activity is a concern for the survey, exploration and marine transportation phases of offshore hydrocarbon activity. Under the right conditions, accumulation of ice on structures can quickly lead to instability. It is, therefore, important to have statistical information on accumulation rates and their maximum duration for use in design. The problem is presumably more acute for vessels which must try to make headway during storm conditions than for fixed platforms (Shellard, 1974). (In such cases, ships' captains may be forced to decide whether or not to lie close to sea ice edges where structural icing rates would be less due to reduced wave activity, but where the possibility of having damaging ice floes driven against their ships is increased.)

Sea ice is an ever-present concern for offshore activity in portions of the Canadian offshore. Even in those areas which may clear of ice only during the July-to-October period of the year, there is frequently a threat of ice floes moving into them due to changing wind conditions. A number of aspects of sea ice must be considered. Thickness is a major concern whether it be due simply to normal growth during the winter or to ridging due to the interaction of adjacent ice masses. Age is also very important because when ice floes survive through several winters, they become increasingly strong as the brine in them is replaced by fresh water which refreezes. Such "old" ice poses the greatest problems for marine transportation. Concentration (percentage of the water surface covered with ice), extent, and the mobility of the ice are concerns as well.

Significant concentrations of icebergs characterize eastern Canadian waters where in many instances, they are embedded in sea-ice cover. Their size and strength make them formidable enemies for any offshore activity. During the open water season, their mobility is increased when they are freed of surrounding sea ice. Scouring tendencies of icebergs (and of heavily ridged sea ice) are important when considering any sea-bed pipelines.

Visibility is a consideration for both marine and airborne activities. While modern detection systems have somewhat reduced the problem for vessels on the high seas, the efficient operation of port facilities and offshore structures subject to the impact of ice features can still be dependent upon good visibility conditions. Logistic support in the form of aircraft, particularly helicopters, is also susceptible to reduced visibility (in addition to other poor flight conditions such as low ceilings and in-cloud icing).

Water currents in association with surface winds play a significant role in the movement of sea ice and icebergs, the importance of which has been discussed above. Knowledge of this combination is particularly vital in modelling the movement of possible oil spills. Bottom currents are of concern for sea-bed pipelines as they can cause sediment washouts resulting in unsupported pipelines which consequently become overstressed.

2.2 Importance by Geographical Area

2.2.1 Arctic

The vast extent of the Canadian Arctic results in important differences in the relative importance of each of the various climatic and related elements, depending upon the particular area of the Arctic under consideration. These differences are superimposed on a general offshore climatic regime which includes sea-ice cover for 9 months of the year with a short navigable season from mid-July to early October. Storm activity is at a maximum in the fall and spring and the temperature pattern features below-freezing temperature for 9 months of the year, extensive periods of -35°C and below readings in winter, and maxima seldom exceeding 10°C in summer (Maxwell, 1980, 1982). Generally, it may be said that wind and ice are the two main issues of concern across the Arctic.

Beaufort Sea

As exploration activity is being carried out in winter, on artificial islands, as well as in summer from drillships, the climatic regime is of concern throughout the year.

During the July to October period, sea ice generally clears from the southern Beaufort Sea with the polar pack retreating to a couple of hundred kilometers offshore. Under such conditions, drilling can proceed continuously except when onshore winds cause intrusions of old ice from the pack or when generally strong winds create high wave conditions or serious structural icing situations. The expected extremes of these conditions dictate design limits both for the drillship itself as well as its positioning. The termination of the drillship operating season is related closely to ice growth both at the drillsite and at the overwintering site.

The use of artificial islands for winter drilling removed the concern for the drilling structure due to impinging sea ice. It is the island itself whose design must conform to expected wind, ice movement and winter current conditions so that likely erosion rates can be countered. Further, the very presence of the island may have important implications in terms of altered spring sea-ice break-up patterns.

Sverdrup Basin-Western Parry Channel

As a result of the extensive amounts of old ice which characterize this area, siting and routing decisions are mainly based on conditions of that ice. For example, proposed tanker routes from Beaufort Sea avoid M'Clure Strait in western Parry Channel because of the old ice that almost continuously chokes the western half of that waterway. Instead, they follow Prince of Wales Strait to the east of Banks Island where first year ice predominates and which frequently clears during the navigation season.

To the northeast of M'Clure Strait, in the Sverdrup Basin, sea-ice clearance during the summer is very limited so that drilling windows are short and very uncertain. For that reason, winter drilling is preferred as it is possible to operate on the sea ice from strengthened ice platforms - the sea ice exhibiting essentially a fast ice condition during the winter.

While wind remains an important factor in this area by virtue of its role in sea-ice movement, particularly in summer, its overall influence is lessened in that the sea ice presence reduces its direct interaction with the sea surface. Thus, the potential for high wave conditions or severe structural icing events is greatly reduced in comparison with the Beaufort Sea or Baffin Bay areas for example. It is important to note, however, that wind chill can be a severe problem for operations in the Sverdrup Basin as temperatures are among the lowest experienced anywhere in the Canadian Arctic.

Lancaster Sound-Northwestern Baffin Bay

As we move eastward, wind once again becomes increasingly important to offshore operations. Sea-ice conditions are typically first year ice often with complete clearing during the July-to-October period. At that time, wind could disrupt drillship activity by advecting old ice floes into this area from the east or the west. During winter, wind contributes to an ice cover which although complete is constantly in motion in most winters thus precluding on-ice drilling such as is possible in the Sverdrup Basin.

The open water season allows a drilling window of several months, but operations are subject to potentially high wave conditions and structural icing possibilities. There are many similarities to the Beaufort Sea in this regard, although higher wave conditions are possible in the Lancaster-Baffin area due to extensive open water fetches to the east and southeast.

Storm activity is increasingly a concern as the major storm trajectory in the Canadian Arctic lies to the east, extending northward from Davis Strait along the eastern side of Baffin Bay. There the combined effects of high winds, high waves, structural icing, extensive cloud and poor visibility must be considered.

In this area, iceberg occurrence begins to be a concern also. Large numbers of icebergs calve from Ellesmere Island and Greenland and pass through northwestern Baffin Bay on their way southward. Some of them enter Lancaster sound typically along its north side and then exit eastward along its south side.

Western Baffin Bay-Davis Strait

This region is completely under the influence of the major storm trajectory mentioned above, along which storms enter the eastern Arctic from the south. As such, the effects of storms combining critical levels of several climatic variables is a significant concern particularly during the latter half of the drilling season when storm activity is most frequent.

Similar to Lancaster Sound-northwestern Baffin Bay, this area presents an ice regime which is characterized by complete sea-ice cover in motion during much of the year. Clearing occurs during July-October and is usually complete although some sea ice can remain in the coastal waters between Cape Dyer and Clyde, remnants of the ice bridge that often extends across Baffin Bay to Melville Bay at the beginning of break-up. More of concern to offshore activities at this time of year is the high concentration of icebergs in these waters. The southward flowing cold Baffin current carries these icebergs continuously through the area and on to the Labrador Sea.

Hudson Bay

In this area, wind again has a very important role. Icebergs are not present and sea ice is of the first year type although some older forms can be found occasionally in Foxe Basin to the north. Sea-ice clearance is total in summer with a navigable season of July-to-October.

Wind's major influences are in the development of high waves as appreciable fetches are possible across Hudson Bay and in the occurrence of high wind chill beginning during the October-November time of the year. Structural icing potential is also high in October.

2.2.2 Atlantic

The Atlantic offshore of Canada can be divided into the areas of the Labrador Sea, Grand Banks and Scotian Shelf. These are considered together in the following paragraphs.

The Labrador Sea and Grand Banks areas are both transportation corridors and potential areas for hydrocarbon reserves. Climatologically, a common characteristic is the presence of moving pack ice during winter and early spring. Icebergs, which are calved from glaciers ending in Baffin Bay to the north, drift southward through the fall and winter to menace shipping and drilling in these waters.

Storms frequently traverse the southern parts of the Labrador Sea, Grand Banks and Scotian Shelf. The wind and wave climate on the Grand Banks is probably the most demanding anywhere in Canadian waters. Juxtaposition of warm/cold air and water currents south of the Maritimes and Newfoundland creates the ingredients necessary for the development of extremely deep and extensive lows with strong winds and high seas.

The near presence of the Gulf Stream as a source for relatively warm moist air results in frequent persisting cloud and fog when the winds are favourable. Along the continental margin on the east coast, the battle between cold and warm air masses gives rise to conditions which make freezing precipitation a frequent occurrence.

It is a bitter irony that one of the most promising areas for oil exploration, the Hibernia area on the Grand Banks, is also one of the most hazardous in terms of climate. 100-year return maximum winds are estimated to be on the order of 110 to 115 knots with a 100-year extreme maximum wave of about 35 metres(among the highest in the world). Strong winds and currents make icebergs a problem for pipelines and sub-sea well facilities because these bergs scour the bottom at times and would tear out anything unprotected or even firmly attached.

In part because of the Ocean Ranger disaster, human safety is becoming a more prominent concern on the east coast. Hydrocarbon fields are very far from bases for resupply and emergency services (search and rescue, and hospitals). Helicopter operations are essential, but can only be carried out when route and destination conditions are favourable. Such things as strong winds and atmospheric icing conditions will also reduce the relative amount of time that it is possible to carry out such operations. As far as marine resupply and construction operations are concerned, high winds, high sea state and reduced visibility are logistics problems.

Clearly, climatic information on multi-dimensional weather windows will likely be a very real constraint on feasible design and construction of offshore facilities in the Atlantic area.

2.2.3 Pacific

The Pacific Ocean areas off Canada's west coast seem at first to be a relatively benign environment for offshore activities. Temperatures are relatively mild, tempered by a fairly long over-sea trajectory. Freezing spray is not frequent and there is no pack ice or icebergs to speak of. The narrow width of the continental shelf means that drilling will be carried out close to shore and supply routes to the mainland could be minimized.

The Pacific, however, is a very large ocean and although the generating potential for strong winds in synoptic scale systems may not appear to be as great as for the Atlantic, the weather systems on the Pacific side are often of a fully-developed nature. This contributes to strong wind and high wave regimes.

The wind regime is complicated by the nearby mountains and their rough topography; thus it is not readily modelled using coarse resolution field data as has been attempted for other offshore areas. Mesoscale modelling may be necessary to produce usable hindcasts of wind. A further problem characteristic of the West Coast is outflow winds or the "squamish". This refers to the streaming of cold arctic air (which has previously invaded the B.C. interior) through fjords along the coast at considerable speed.

Waves in the Pacific have ample opportunity to grow to their full potential. Swells of long period propagate from long distances to mingle with locally generated seas. An extreme wave of on the order of 30 metres was observed during exploratory drilling off Vancouver island before a moritorium on drilling came into effect in the mid-70's so that environmental concerns having to do with risks from spills could be resolved. This has still not been achieved. The coastline is aesthetically pleasing and highly vulnerable to pollution from spills. Winds and currents are such that if spills occur, it is certain that large areas will be at hazard. Risks from and to the environment must be minimized and visibly so.

2.2.4. Design Data Comparison

Table 1 indicates current estimates of 50-year annual return period values for both wind speed and significant wave height for various areas of each of the Arctic, Atlantic and Pacific. While they are drawn from various sources and reflect different methods of analysis, they do give a rough comparison of conditions over the Canadian offshore.

3. Sources of Data

The climatic information necessary for offshore routing and siting decisions is derived from several sources: generally short-term or non-uniform observations from ships and drilling platforms, the observing programs at land-based weather observing stations and at lighthouses, satellite and airborne observing programs, and hindcast data from objectively analyzed data fields and model simulations. None of these sources is completely satisfactory by itself and the necessary climatological guidance must usually be inferred from a combination of them. Figure 1 provides an example of the nature of the AES observing network, ship observations coverage and gridded data points in the Lancaster Sound-northwestern Baffin Bay area.

Ships and drilling platforms obviously offer the most direct data for the offshore areas. Short-term data sets, varying observing locations (e.g. data from ships which are in transit), and non-uniform observing procedures (particularly in terms of types and locations of meteorological instruments) are problems, however. Thus such data are not particularly amenable to time series or extreme value analysis. Usually the data are handled by combining all observations from various locations within defined geographic areas, for example, a 5° x 5° latitude-longitude square. Statistical analyses are then performed on the merged data set. As far as areal coverage is concerned, the Atlantic area has the highest concentrations of observations, followed by the Pacific and Arctic. Referring to the example in Figure 1, there are a total of about 3000 observations available for each of the two areas (labelled 11 and 12) over the entire period of record. This may be contrasted with a coastal observing site such as Resolute where an hourly observing program is in operation, resulting in the accumulation of about 9000 observations in a single year.

The land-based weather stations of the AES observing network offer the advantages, in most cases, of reasonably long, continuous observing programs at fixed locations. The data from these coastal or island locations are suitable for the time series and extreme value analyses that are very important in providing suitable engineering design information. On the other hand, being land-based, the data do not necessarily reflect offshore conditions. Certain critical variables such as wind speed may be underestimated by 30 percent or more if such data are used directly. Additionally, in many areas, particularly the Arctic, coastal stations are sparse so that estimates for many offshore sectors are not even possible using such an approach.Again looking at Figure 1, there appear to be a large number of observing stations along the coasts of or near to Lancaster Sound, for example. Some sites, however, are no longer in operation or have short-term records (Dundas Harbour, Arctic Bay); others (such as Pond Inlet) are influenced by local conditions. Resolute is the only really applicable long-term station and it is considerably to the west.

To supplement the AES land-based data, various non-standard data sets from land-based locations are available. In both the Atlantic and Pacific, the numerous lighthouses have taken observations, in some cases over appreciable periods of time. The quality of these data needs careful assessment as observers have generally minimal training, the type of equipment used and its siting is variable and the observing schedule itself is often not uniform. For the Arctic, supplementary land data are available from the Polar Continental Shelf Project. Data are gathered twice daily at each of the research sites that the Project supports. Observers are given elementary training and efforts are made to ensure uniformity in observing equipment and techniques. The data, however, may only exist at a given site for a week or so and at best, data records may extend over several summers at one site.

Satellite observing programs offer promising possibilities to improve our knowledge of the offshore climate directly. To date, most use has been made of information which can be derived on sea-ice extent and coverage. Increasingly, the possibilities for determining temperature, wind and wave information are being recognized, however. Periods of record are not appreciable as yet in climate terms and digitizing considerations are significant, but this may provide in the long term, the most feasible way to develop a useful, direct offshore climate data archive.

Aerial sea-ice reconnaissance is still the most significant part of the AES ice observing program. Visual, laser profilometer, sideways looking airborne radar (SLAR) and microwave techniques are all integrated to provide areal ice condition charts for the Arctic in summer and the Atlantic in winter. Over 25 years of such data are now available.

In order to fill the gap in direct offshore climate data, hindcast data are now being used extensively to provide design-related information. Gridded surface pressure fields can be used to develop wind climatologies and these in turn may be variously combined with gridded air temperature fields, knowledge of water temperatures and geography to derive such fields as waves, wind chill and structural icing potential. Such analyzed fields offer the advantage of complete coverage in the offshore areas, a continuous record at fixed intervals (6 hours typically) and an appreciable length of record (over 30 years). On the other hand, the smoothing inherent in objective analysis may mean that extreme events are underestimated - an important consideration for design purposes.Figure 1 shows the surface pressure grid point locations in the Lancaster Sound area. Data at each of the points can be used with various interpolation techniques to derive geostrophic winds at any location within the area covered by the data set.

4. Analysis and Presentation of Data

4.1 Types of Analysis

For the climatic elements discussed here, statistical analyses in forms applicable to design purposes are necessary. Thus, the emphasis is on probabilities, percentiles, exceedance values, extremes, return periods, durations and time series trends. Contingency analysis for several climatic elements is also of concern. As critical values often occur in combination during severe storms (e.g. high winds, low visibilities, high waves, rapid structural icing accumulation), the effect on an offshore drilling platform could be disastrous. For this reason, climatologies of storm frequency, intensity and trajectories are vital and case studies of individual extreme situations are necessary to understand fully the interactions and impacts of the various climatic elements.

4.2 Analysis Systems

To access the different sources of data outlined in Section 3 and produce the design type climate information necessary, the AES Canadian Climate Centre has developed several computer based systems capable of providing a full range of area or site specific analyses (Swail et al., 1983).

MAST (Marine Statistics) is a system for accessing ship observations to produce summaries and graphical analyses of winds, waves, air and sea temperature, wind chill, sea spray icing, visibility and cloud. Presentation is in terms of frequency of occurrence, means, medians, exceedances, etc. Several examples of MAST analysis are shown in Figure 2. LAST (Land statistics) and GASP (Gridded Atmospheric Statistics) were developed so that similar analyses would be possible for landbased data and numerical or objectivity analyzed data fields such as the NEDN (Naval Environmental Data Network) data fields obtained from the U.S. Fleet Numerical Oceanographic Center. CONAN (Contour Analysis) was developed to give analysis of the spatial variability of these fields. With CONAN, it is possible to map means, medians, exceedances, percentile values and extremes of environmental data fields. DUST (Duration Statistics) was developed to produce analyses of the duration of critical events and to produce extreme value (Gumbel) analyses of meteorological and oceanographic elements in accessible data bases. Finally, a system which allows analysis of gridded surface pressure data will, when completed, enable pressure centres to be studied in terms of trajectories, frequencies of occurrence, intensities and variability.

Access to the products from these systems is, or will be soon, available through AES regional Scientific Support Divisions, the Canadian Climate Centre or directly on AES' Downsview computer for those users with the capability and need for access. The systems are complex and powerful, yet for most common purposes, easy to use because of their menu-driven nature. They are a new and direct avenue for access to climatic information for decision making on offshore routing and siting.

5. Climatic Change

For exploration activities which at any particular site or area might have a lifetime of perhaps half a dozen years at most, the importance of climatic change and how it might invalidate design information based on the existing data base is not great. For production activity which might be expected to last 20 to 30 years or longer, however, consideration of possible future climatic change is important.

An indication of recent climate conditions is shown in Figure 3. The temperature trends at several eastern arctic locations over the existing periods of record indicate a cooling period beginning in the early 1950's and continuing until the early 1970's. Thereafter a leveling-out and more recently slight warming has occurred. These then represent "existing conditions", if you will, from which design information is currently derived. Any significant deviation of climate in the future from the range of these existing conditions could have important implications for design information. (An important point to note is the fact that the trends in the eastern Arctic are not necessarily similar to those that have occurred in other Canadian offshore regions. Each region must be evaluated separately.)

While both warming and cooling relative to existing conditions is possible future warming (mainly induced by increased atmospheric CO_2 concentration) is considered more likely. Global circulation models based on CO_2 doubling indicate that such a warming trend could amount to an increase of 2 to 3°C in the mean annual temperature of the northern hemisphere by the mid-21st century or soon thereafter. This warming is not expected to be uniform across the whole hemisphere; for example, the Arctic will experience a much greater surface temperature increase (perhaps 10°C) generally than other latitudes. This is related to the general thermal stability of the lower levels of the arctic atmosphere (so that the expected warming will be concentrated close to the surface rather than distributed throughout the troposphere) and to the retreat of the highly reflective ice and snow surfaces. In the Atlantic and Pacific areas between 40 and 55°N, surface warming is expected to be comparable to the hemispheric mean value.

Similarly, there is seasonal variability in the expected warming. In the Arctic, the magnitude of the warming in the summer would be much less than that in the winter. In summer, sea ice is thin or absent in many areas, the surface albedo reduces significantly and net incoming solar radiation increases. The additional solar radiation is used either for melting the sea-ice upper surface or for warming the ice-free mixed layer which has a large heat capacity. Thus the summer warming of the surface air turns out to be relatively small (Manabe and Stouffer, 1979). At the latitudes of the Atlantic and Pacific offshore areas, warming is expected to be fairly uniform throughout the year.

While obviously, over the foreseeable lifetime of offshore production (say 30 years), only a portion of the warming discussed above would occur, it would be enough so that it would need careful consideration during any design work.

A pronounced arctic warming has a number of implications for climatic and related elements which bear on arctic offshore routing and siting decisions. The increased warming relative to equatorial areas will alter the temperature difference between the pole and equator which helps to drive storm systems around the globe. Particularly, it appears there would be a more uniform gradient of air flow between pole and equator so that circulation will slacken in the mid-latitudes but intensify at high latitudes. Thus storm activity embedded in that flow will be more prevalent in the Arctic.

The increased temperature and increased storm activity will lead to increases in such elements as wind speed, wave action and structural icing potential - all of major significance to offshore activity. For example, increased wave action will result in greater wave heights and longer durations and also in increased duration of wave period conditions critical to fatigue problems. Increased structural icing potential would be reflected in both intensity and duration. The season might be shifted and its length overall would increase. The geographical extent of the icing-prone area will also increase. Increased temperature in itself will contribute to lower energy requirements (for compressors) needed to keep oil and gas flowing in pipelines. There would be reduced permafrost extent and attendant frost heave problems.

Due to the importance of sea ice and icebergs for offshore routing and siting, their response to future warming is highlighted in the following section.

5.1 Implications of Warming for Sea Ice and Icebergs

At present, sea ice presence where first-year ridging or multi-year floes and hummocks occur poses major problems for tankers trying to make headway through it and for fixed or dynamically positioned platforms which must either be designed to withstand the ice or be prepared to move off-station to avoid it. There is also some problem due to scour by ridges and hummocks in some of the shallower waters which could affect sea-bed pipelines. In these cases, strict design criteria must be met. This involves large dollar outlays which add significantly to the cost of marketing any future reserves. This is a particular problem for the Arctic, mainly in the Parry Channel, Beaufort Sea and Queen Elizabeth Island areas.

The advent of warmer climate conditions would lead to a decrease both in the overall extent of sea ice and in the thickness of that ice which continues to exist. At the same time, however, the lesser concentrations of ice generally would probably allow more multi-year floes, most of which are presently restricted to the Polar Basin and among the High Arctic Islands, to penetrate into more southerly waterways where Beaufort-related transportation activity is expected to occur. In the long term, such movement of old ice would disappear, but it would likely be a problem at least for the lifetime of any presently foreseen production activity. Another concern might be increased wave/structural icing potential as increased storm activity affects waters that are no longer damped by sea-ice cover.

The threat of icebergs is mainly restricted to the eastern Arctic and the waters east of Labrador and Newfoundland. Problems relate both to collision with platforms or tankers and to seabed scour which could destroy even embedded pipelines used to connect production platforms to coastal markets or collection points.

A future warmer environment would likely result, at least in the short term ,in increased calving from arctic glaciers so that concentrations of icebergs in arctic waters would be greatly increased. On the other hand, melting of the icebergs would probably accelerate so that fewer or at least smaller ones would be likely to survive to affect the southern offshore areas.

6. Discussion

Climate plays a vital role in the siting and routing of offshore hydrocarbon-related activities in Canada. In order to achieve an optimum balance of costs vs. environmental risk, there are a number of specific climatic and related elements which must be taken into account during the design phase; these include wind, waves, structural icing, temperature, wind chill, visibility and cloud, and sea ice and icebergs. Each of these has a varying degree of significance depending upon the particular offshore region being considered and the time of year of interest, and so must be carefully evaluated for each distinct offshore project.

An important point to remember is the fact that expected extremes of individual climatic elements may, for a specific location, not be severe enough to be an important design concern. It is possible, however, that in combination with some other element the resulting impact could be significant. Thus it is vital to recognize that storm situations where significant thresholds of several elements may be reached at the same time must be thoroughly evaluated. This could be the case for severe structural icing or wind chill events, for example.

There is a fairly good understanding of what climatic data are most important for a particular phase of offshore exploration and production, and of the type of analyses that are most needed. Further, powerful tools for processing the data into the required forms have been developed. It is the all-important intermediate step which now requires and is receiving the most attention. That is the acquisition or development of the appropriate climatic data. This problem reflects the very sparse nature of the existing offshore climate data base. Even those data which do exist usually are not amenable to statistical analysis for critical design needs such as extremes and durations. The collection of new data is being encouraged, but in the time frame of present offshore activity, there is insufficient time to build sufficiently long data series from which reliable design statistics can be derived. To circumvent this, the trend has been to develop synthetic climatologies where possible.

A good example is the use of gridded surface pressure data fields which allow geostrophic winds to be calculated. How directly applicable such winds are to design (which generally requires surface wind data) remains an open question. On one hand, they are derived from gridded data which may smooth the most extreme events (which are usually the most important for design); on the other hand, they may not always reflect the frictional component of actual surface wind so that they might be overestimates in that respect. It is clear that there is a complex question of interpretation or adjustment of such data which must be addressed. Generally, it must be done on a site or small areal basis because each geographic area is different in terms of the distribution of land and water surfaces and the relative frequency of cyclonic and anticyclonic activity that occurs there.

Given that the problem of selecting and/or adjusting the most appropriate data is resolved, the question of climate change becomes an important concern. Any statistics which are developed on the basis of existing climate data or gridded fields with the intent of applying them to the design of production expected to have a 30 year lifetime could be put into question by a warming (or cooling) trend in climate during that time. Resulting under-or over-design could mean either significant capital losses and environmental damage or unnecessarily expensive construction and development costs.

The question of climatic change is far from simple. The possibility of warming or cooling must first be resolved, then the manner in which such a change would be reflected on a regional basis such as for the Arctic or Pacific or Atlantic. How further would such change affect other climatic elements and then how would these impact on offshore activities themselves? There is such a chain of connecting assumptions to be made that room for error is large given our current state of knowledge. Nevertheless, qualitative assessments can be usefully attempted now and hopefully refinements in them will be possible in the near future as we are able to study past and present climate patterns and their relationships with offshore activity in more detail. We will then be in a position to make any necessary adjustments to currently derived design values. This is not done now, but it is clearly needed.

7. References

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Table 1. Estimates of Wind and Waves for Selected Canadian Offshore Areas

Area	50-Year Annual Return Period Values: Wind Speed (km/h)	50-Year Annual Return Period Values: Significant Wave Height (m)	Source
Arctic			
Beaufort Sea	128*	8.0*	Berry et al., 1975
Lancaster Sound-Northern Baffin Bay	142*	11.2*	Lachapelle and Maxwell, 1983
Southern Davis Strait	172	10.0	Unpublished AES data analyses
Atlantic			
Labrador Sea	185	11.8	"
Grand Banks	202	12.5	"
Scotian Shelf	178	12.2	"
Pacific			
Queen Charlotte Islands	165	-	"

* July-October values

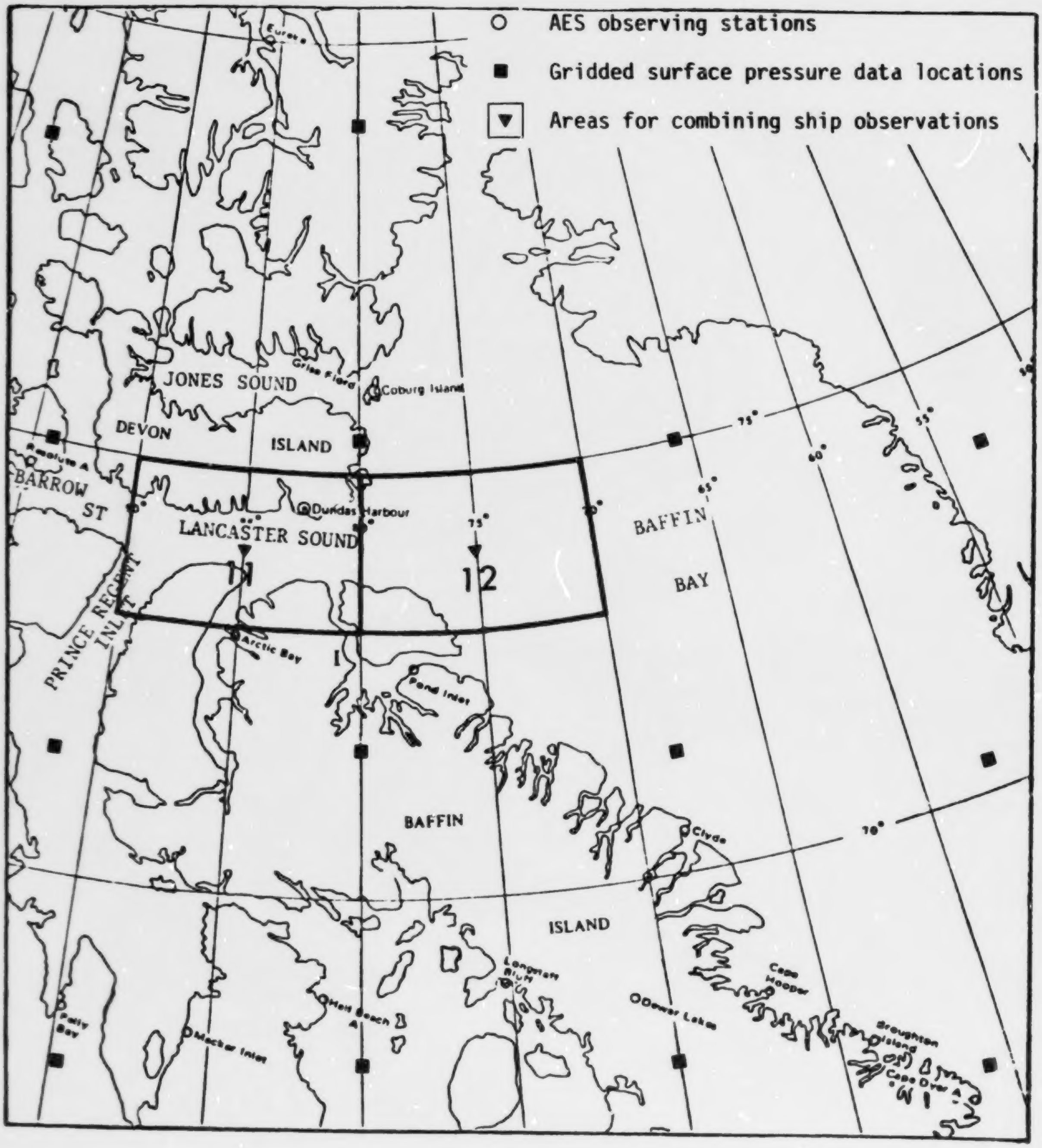

○ AES observing stations
■ Gridded surface pressure data locations
▼ Areas for combining ship observations
Eureka
JONES SOUND
Grise Fiord
Coburg Island
DEVON
ISLAND
Resolute A
BARROW
ST
Dundas Harbour
LANCASTER SOUND
PRINCE REGENT
INLET
11
12
75°
BAFFIN
BAY
Arctic Bay
Pond Inlet
I
BAFFIN
ISLAND
Clyde
70°
75°
60°
65°
55°
50
Longstaff
Bluff
Cape
Hooper
Dewar Lakes
Broughton
Island
Cape Dyer A
Pelly
Bay
Mackar Inlet
Hall Beach
A

Figure 1. Data Coverage for Lancaster Sound - Northwestern Baffin Bay

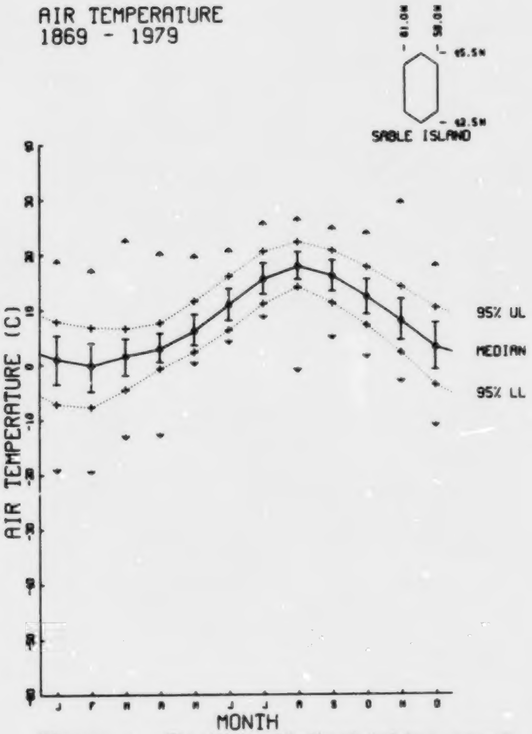


Figure a. Basic statistical tables graph.

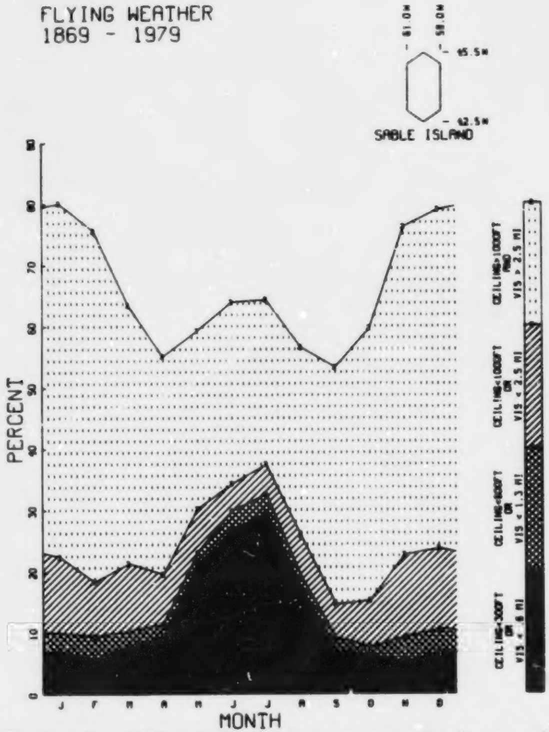


Figure b. Univariate frequency analysis graph.

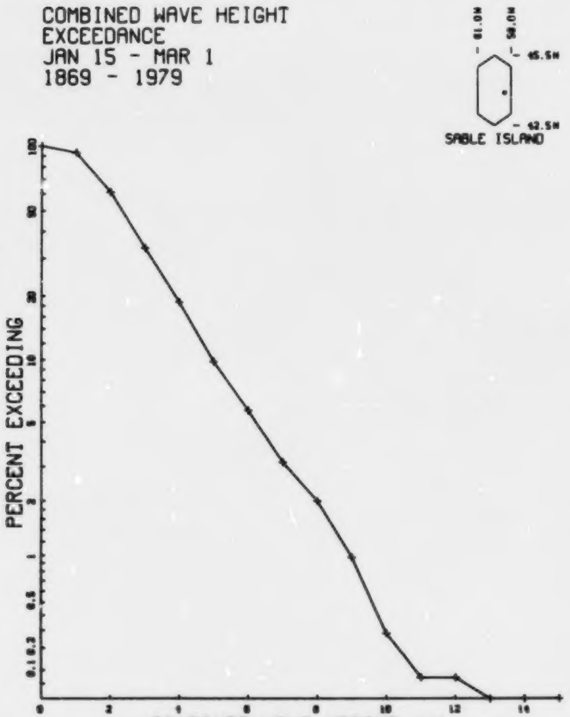


Figure c. Exceedance graph.

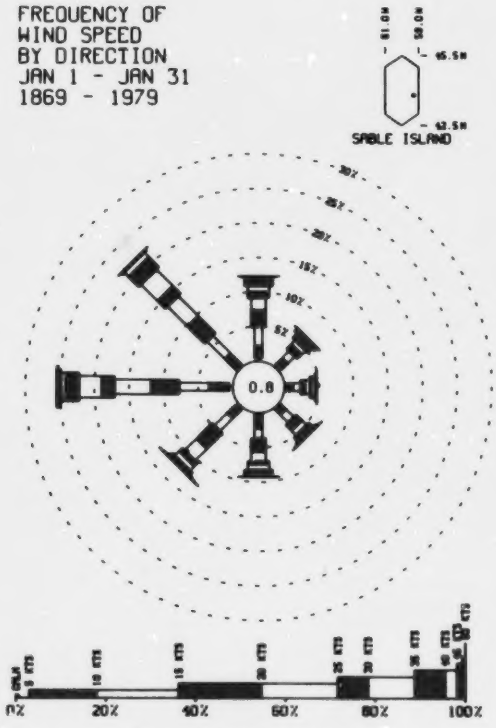


Figure d. Directional plot or roses.

FIGURE 2. SELECTED EXAMPLES OF MAST ANALYSIS FOR AN EAST COAST LOCATION.

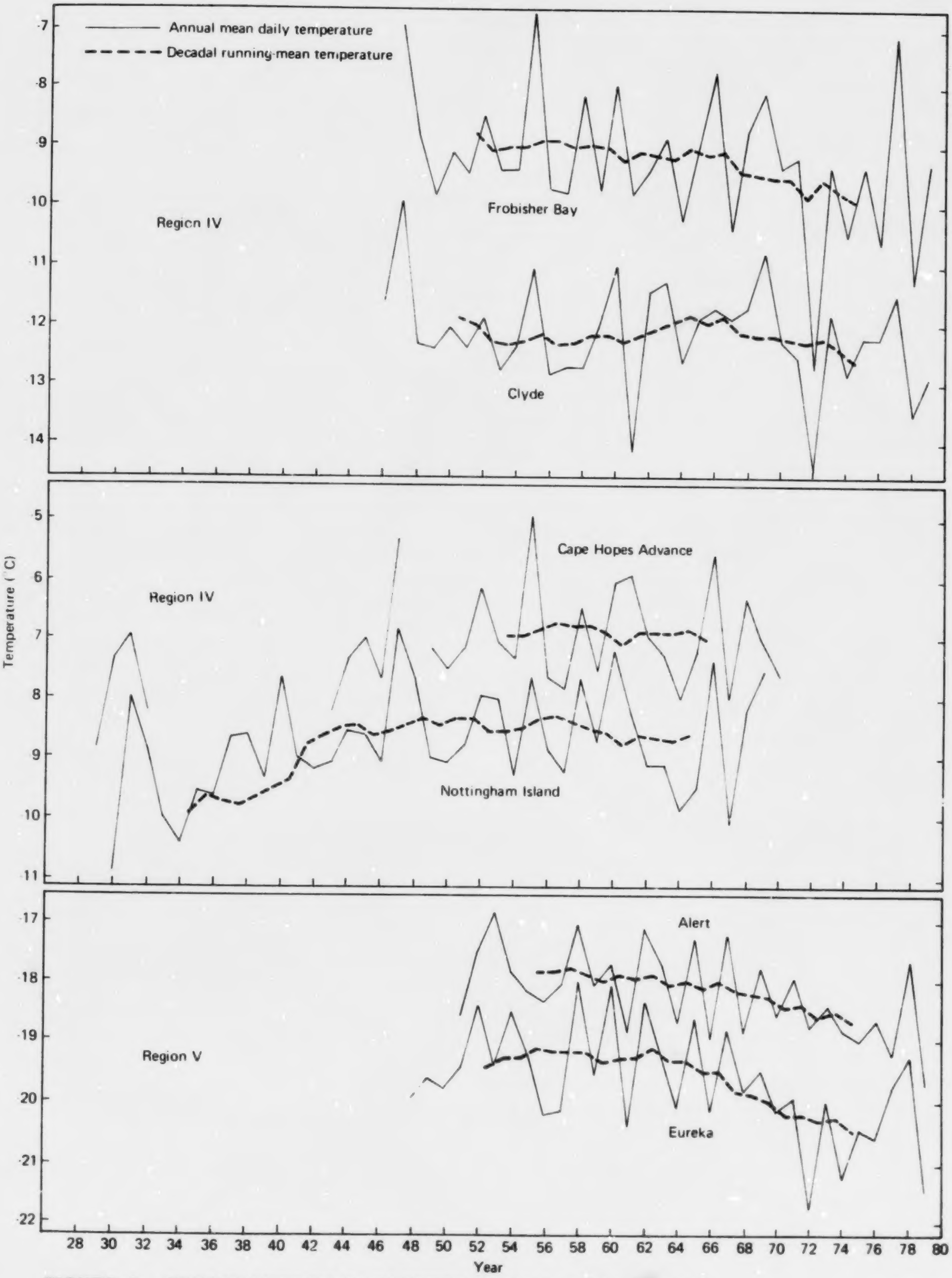


FIGURE 3. RECENT TRENDS IN EASTERN ARCTIC TEMPERATURE.

"A MULTIPLE USE CORRIDOR IN NORTHWEST ALBERTA"

Ian F. H. Scott
Dome Petroleum Limited
P.O. Box 200, Calgary, Alberta

ABSTRACT

This case history highlights Dome Petroleum Limited's experience with the siting of a gas plant, routing of an associated gathering system and construction of both in a somewhat remote, environmentally-sensitive area in Northwest Alberta. Specifically, the paper describes briefly the overall criteria used to site the gas plant and route the gathering system. A major component of this development was the establishment of a multiple use utility corridor involving potentially three different pipelines - a gathering line, a sales line and a liquid hydrocarbon line - to and from the gas plant, and a power line to the gas plant. Dome's role in coordinating the routing and construction of the three pipelines and one power line is discussed. The paper highlights the utility corridor route selection criteria and its compatibility with the requirements of each company and various government agencies. The paper focuses on a number of the potential problems identified during the planning stage which related to the possibility of three or four companies working within the utility corridor at the same time and also those problems which were not identified during planning but did occur during construction. Also, a brief review of potential future problems arising from different right-of-way management methods of each company within the corridor is made. The paper concludes by emphasizing the need for good coordination and communication during both planning and construction and provides recommendations for the development of future multiple use corridors.

INTRODUCTION

Over the last few years Dome Petroleum Limited has been very active in hydrocarbon development in the Deep Basin area, south of Grande Prairie, Alberta. By July 1980, Dome Petroleum had drilled and tested 13 wells, was drilling and testing 12 wells and proposed to drill an additional 20 wells in the Cutbank-Kakwa Rivers area. At that time it was decided that on the basis of the information obtained from the existing wells, the region had good potential for natural gas and gas liquids (C_4+) production. Consequently, Dome decided to build a gas processing plant and a gas gathering system and liquid sales line.

This paper highlights Dome's experience with developing a system in the Cutbank-Kakwa Rivers area of the Deep Basin (Townships 61-64, Ranges 5-10, West of the 6 Meridian). The purpose of this paper is to illustrate the planning process used in developing this system and, in particular, identifying where problems occurred.

To simplify this discussion I will examine primarily the plant and gathering system components of the project then review the entire project. The major components which had to be considered included the location of existing and proposed wells, the gas plant, the gas gathering system, sales gas line, liquids sales line and a power line for the plant. Each of these had a direct influence on the location of each other component. As well, since the project is located in Forest Management Units G6 and G7, consideration had to be given how to minimize interference with the logging operations of Proctor and Gamble.

For each component I will discuss the criteria used to select its location, where it was finally located and any particular problems encountered. I will also briefly review the various data resources that were utilized during the planning process. However before I do, I would like to review the various departments within Dome who had a direct influence on the design of the project.

Project Team

The members of the team involved in development planning are shown in Figure 1. Exploitation identified and evaluated Dome's properties, provided reservoir information and provided overall project management. Drilling designed, organized and operated all drilling and this included the construction of new access roads to wells. Oil and Gas Engineering (OGE) designed all facilities, provided liaison between Dome and other companies involved - NOVA, AN ALBERTA CORPORATION (NOVA), Peace Pipe Lines Ltd. and Alberta Power Limited. OGE worked closely with Environmental Affairs on the site and route selection. Also OGE provided direct project supervision during construction. Environmental Affairs was involved in site and route selection and provided liaison between OGE, government agencies and NOVA. Surface Rights worked closely with all departments to obtain necessary land agreements once the site and route were selected.

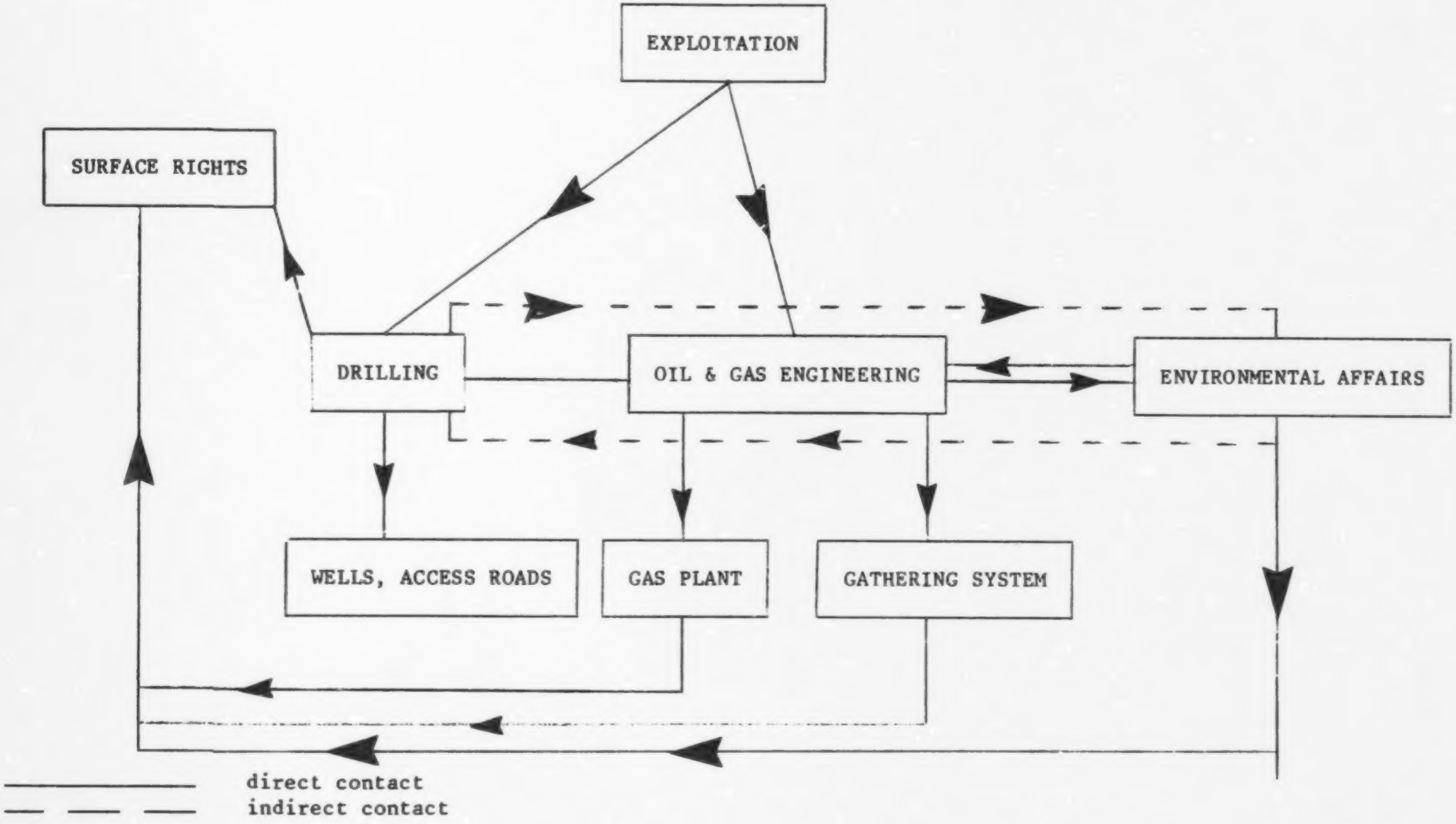
Site and Route Selection Procedures

Initially, the 1:250,000 and 1:50,000 National Topographic Series maps were reviewed to determine suitable potential gas plant sites and a possible gathering system. These were used in conjunction with Alberta Forest 1:50,000 scale maps which provided information about forest cover, existing seismic lines and access roads.

Once the potential sites and possible gathering systems were drawn on the above, a number of aerial reconnaissances were made with a helicopter. During each flight, numerous on-the-ground observations were made to provide better insight about terrain stability and select optimal watercourse crossing locations. Photographs were taken to illustrate unique or specific terrain features for use in the subsequent permit application documentation. Throughout representatives of Alberta Fish and Wildlife and Forest Service were present during these reconnaissance flights to provide input on the various plant sites and gathering system. Following each reconnaissance the site or route were modified on the basis of information provided

FIGURE 1

DEPARTMENTS INVOLVED IN PLANNING PROCESS


EXPLOITATION
SURFACE RIGHTS
DRILLING
OIL & GAS ENGINEERING
ENVIRONMENTAL AFFAIRS
WELLS, ACCESS ROADS
GAS PLANT
GATHERING SYSTEM
direct contact
indirect contact

by government (i.e., critical wildlife areas, unique or sensitive vegetation, unstable slopes) or information gained during six different sites and gathering systems to each was evaluated by the flight itself. In all more than 10 flights were made to determine the best possible plan, site location and gathering system. In addition, contact was made with a number of other government agencies to determine information which could affect location of either the plant or gathering system. These agencies are listed in Table 1. At this stage, the route selection team had assembled considerable resource inventory data, maps, aerial photography and had a number of meetings with governing agencies.

Following this, applications were prepared, submitted and approvals/permits were obtained. Table 2 lists permits and applications received and responsibility of each department for preparation of the applications. Construction commenced December, 1981 and the plant and pipeline were completed May and April respectively.

Plant Site Selection Criteria

In total, six different potential sites were examined as possible locations for the plant (see Figure 2). All but one were found to be acceptable to Alberta Forest Service and Fish and Wildlife. The one site which was not found acceptable (Site #1) was located too close to Long Lake, a recreation reserve. Both Forestry and Fish and Wildlife felt that the plant would not be compatible with land use around the lake.

In examining each location, the following criteria were used:

- Proximity to wells;
- Accessibility of plant for operations;
- Accessibility to Alberta Power's 250 kV line since compressor drivers are electric;
- Accessibility for NOVA's sales gas line and Peace's liquids line;
- Dry, stable soil suitable for constructing plant;
- Minimizing interference with Proctor and Gamble's logging operation, holder of Forest Management Licence;
- Avoidance of recreational areas;
- Avoidance of critical wildlife area;
- Aesthetics.

Site #6 (see Figure 2) was the site chosen. This site was selected because it was close to the best producing wells, there was a good existing road infrastructure to facilitate accessibility; the plant was not too far from Alberta Power's power line, NOVA's sales gas line and Peace's liquids line; the terrain was stable; the site was well drained; the site was not in any unique or critical wildlife areas and the site did not impact any recreation areas. In general, there were no major problems encountered with the construction of the plant.

TABLE 1

1. DEPARTMENT OF ENVIRONMENT
    - Land Reclamation Division

2. ENERGY AND NATURAL RESOURCES
    - Forest Land Use Branch (Edmonton and Grande Prairie)
    - Fish and Wildlife (Edmonton and Grande Prairie)
    - Land Management and Development Branch Natural Areas Coordinator

3. RECREATION AND PARKS
    - Parks Planning Branch

4. CULTURE
    - Archaeological Survey of Alberta

5. ENERGY AND NATURAL RESOURCES
    - Coal Department

TABLE 2

LIST OF PERMITS/APPROVALS REQUIRED

APPROVAL/PERMIT/LICENCE	AGENCY	RESPONSIBILITY	REQUIRED
Pipeline Permit	ERCB	Engineering, Surface Rights, Environmental Affairs	Construction and operation of pipeline.
Clean Air Act Permit & Licence	Environment	Engineering, Environmental Affairs	Construction and operation of plant.
Development and Reclamation Approval	Environment	Engineering, Environmental Affairs	Construction of regulated pipeline.
Permit to Construct Water Crossing	Environment	Engineering, Environmental Affairs	Water crossings by pipeline.
Licence of Occupation (LO)	Energy & Natural Resources	Engineering, Surface Rights, Drilling	Access Roads.
Miscellaneous Lease (ML)	Energy & Natural Resources	Engineering, Surface Rights	Plant Sites.
Pipeline Agreement	Energy & Natural Resources	Engineering, Surface Rights	Pipeline construction.
Use of Explosives in Fish Sensitive Watercourse	Energy & Natural Resources	Engineering, Environmental Affairs	Blasting in watercourse frequented by fish.
Historical Resources Approval	Energy & Natural Resources	Engineering, Environmental Affairs	Archaeological survey.

Pipeline Route Selection Criteria

The criteria for selecting the gathering system and, in particular, the utility corridors were not much different than those commonly used in selecting any pipeline route:

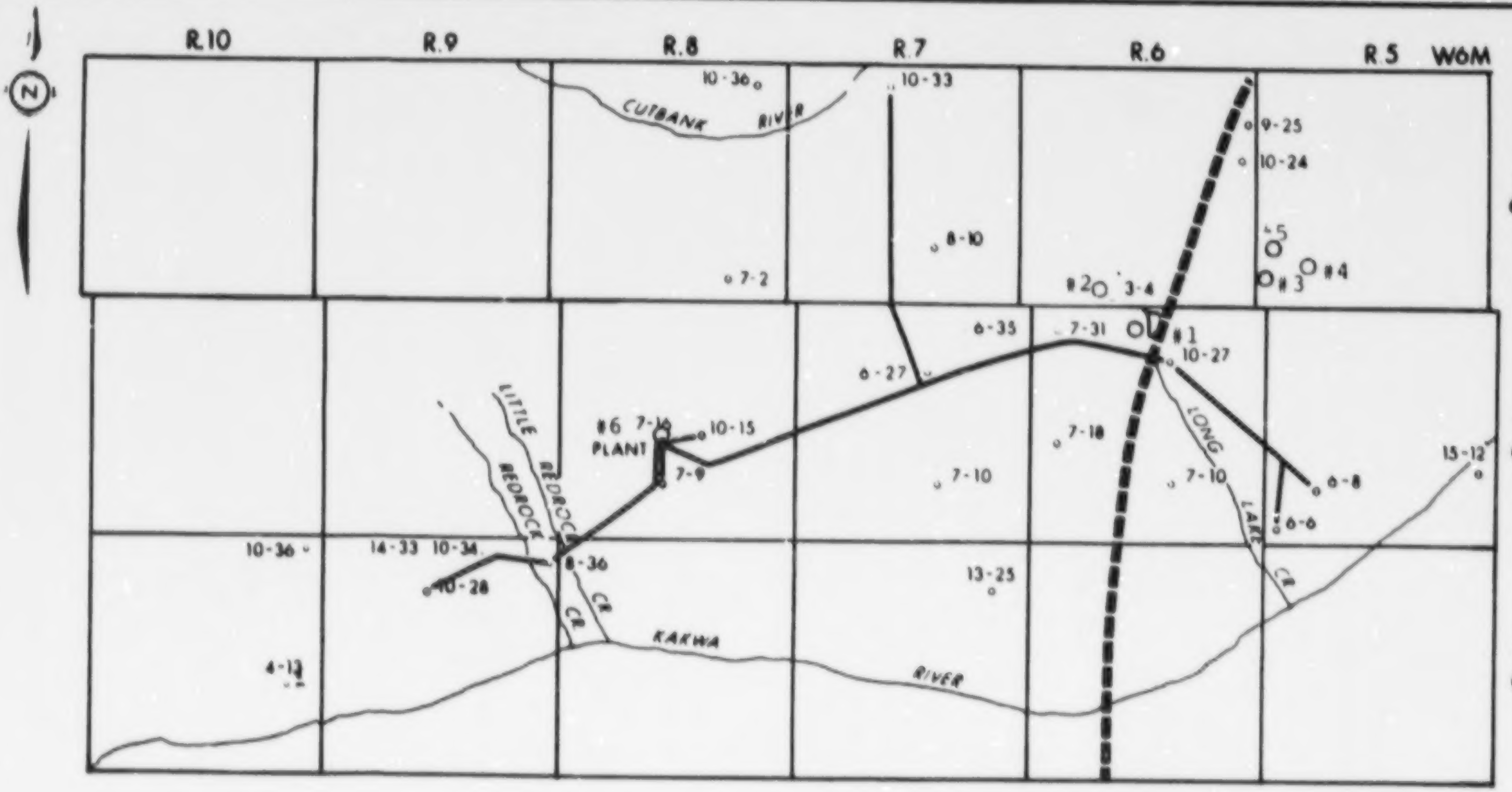
- Termini locations;
- Use of existing seismic lines, roads, rights-of-way, where possible;
- Avoidance of steep or unstable slopes;
- Minimize the number or river crossings;
- Good river crossing locations;
- Avoidance of sensitive or critical wildlife areas;
- Minimize interference with Proctor and Gamble's ongoing and future logging operations;
- Compatibility of Dome's right-of-way with those of NOVA, Alberta Power and Peace Pipe Line;
- Avoidance of recreational areas;
- Avoidance of archaeological sites.

Although at one time there was the potential to tie in 25 or more wells, only 9 wells were tied-in (Figure 3). One of the most difficult aspects of this project was to know which wells would form part of the system. You will recall that initially 13 wells were drilled, 12 were being drilled and tested and 20 more were potential wells. Of the total 9 wells tied in, only 7 were of that original group. Two additional wells were drilled and tested during the planning process. There are other wells which were successful and these may be tied-in later when economic conditions are better. With this change in 16 wells being tied-in modifications were continually being made to the final route up until just before our application for a 70 km regulated pipeline was filed with the ERCB and Alberta Environment.

As part of the overall pipeline route Dome decided to establish a 9.6 km, 42 m wide utility corridor in which all possible services required by the plant could be included within a single right-of-way (Figure 3). The participants in the corridor were NOVA with a 16-inch sales gas line, Peace Pipe with a 3-inch liquids pipeline to their terminal in 15-18-63-5 W6M, Alberta Power with a 25 kV single-pole power transmission line for the plant and Dome Petroleum with an 8-inch gas gathering pipeline to the plant.

Initially Dome was prepared to construct its own liquids sales pipeline to the Peace Terminal but after considerable discussion with Peace Pipe it was decided that Peace Pipe would own the three-inch liquid sales line but Dome would construct the pipeline and lay it within the same trench as Dome's gathering pipeline. It was agreed that Dome and Peace would have joint ownership of the right-of-way.

In addition to the utility corridor, Dome and NOVA established a common corridor alongside Proctor and Gamble's road that runs north to the Cutbank River (Figure 3). Also, Dome and Alberta Power established a corridor east of Range 7 up to where Alberta Power intersects its main line.


N
R.10
R.9
R.8
R.7
R.6
R.5 W6M
T. 63
T. 62
T. 61
10-36
CUTBANK RIVER
10-33
9-25
10-24
8-10
7-2
5
#3
#4
#2
3-4
#1
6-35
7-31
10-27
6-27
#6 7-16
PLANT
10-15
7-9
LITTLE REDROCK
REDROCK
7-18
7-10
LONG LAKE CR
7-10
6-8
6-6
15-12
10-36
14-33
10-34
8-36
10-28
CR
CR
13-25
KAKWA
RIVER
4-13

ALBERTA POWER LIMITED

○ POTENTIAL PLANT SITES
#6 IS ACTUAL SITE

DOME PETROLEUM LIMITED
CALGARY ALBERTA CANADA

PROJECT

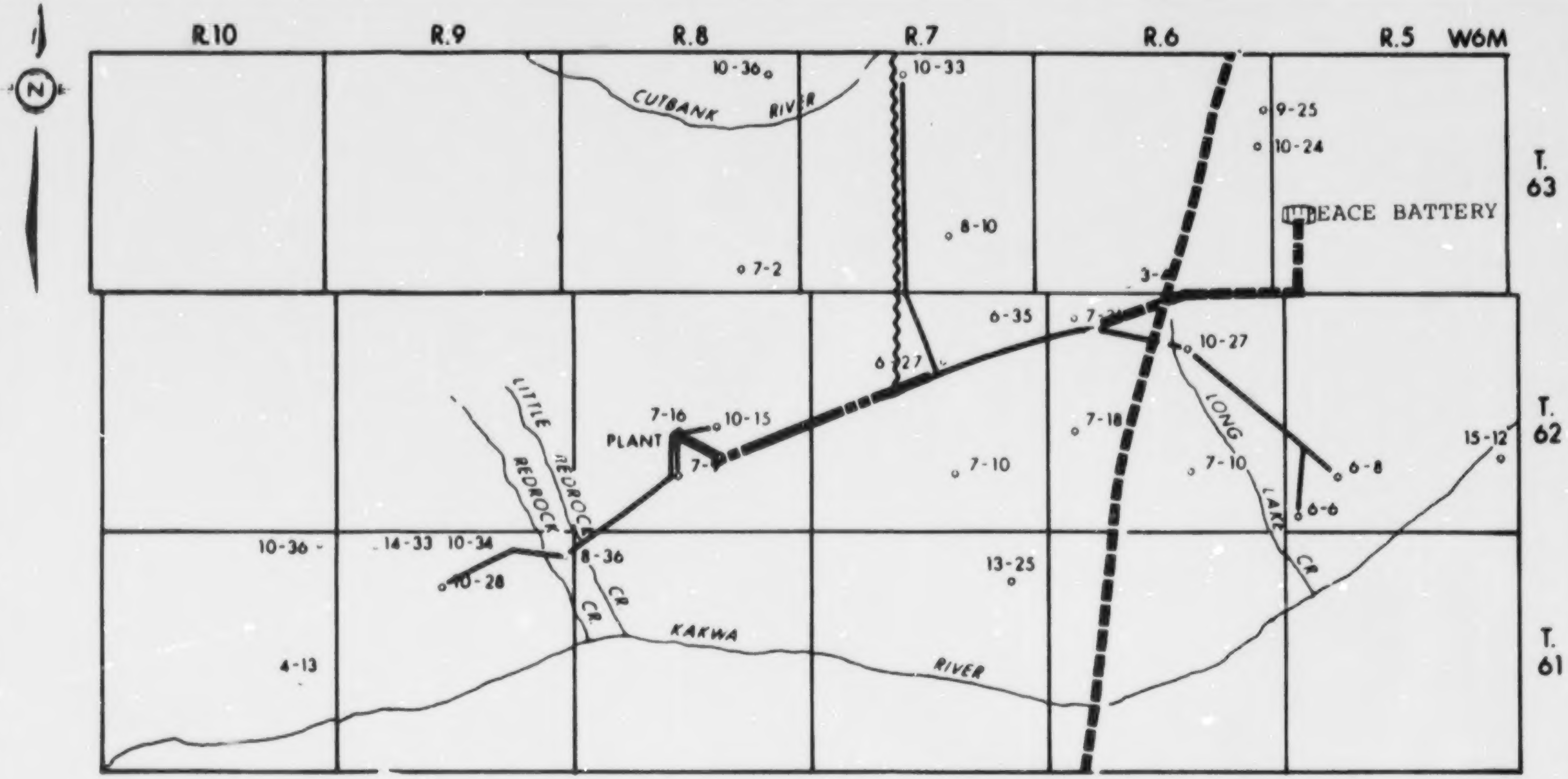
TITLE

FIGURE 2

POTENTIAL PLANT SITES

DRAWN BY B C V W
DATE 81 08 24
DRAWING No. A-CUT-505-06
REV 1
CHECKED BY
SCALE NOT TO SCALE

DP 104 ADP


N
R.10
R.9
R.8
R.7
R.6
R.5 W6M
T. 63
T. 62
T. 61
10-36
CUTBANK RIVER
10-33
9-25
10-24
PEACE BATTERY
8-10
7-2
3-
6-35
7-
10-27
6-27
7-16
10-15
PLANT
7-
7-18
7-10
7-10
LONG LAKE CR
6-8
6-6
15-12
LITTLE REDROCK CR
REDROCK CR.
10-36
14-33
10-34
10-28
8-36
13-25
KAKWA RIVER
4-13
UTILITY CORRIDOR
NOVA'S PIPELINE
PEACE'S PIPELINE
ALBERTA POWER LIMITED
DOME PETROLEUM LIMITED

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DOME PETROLEUM LIMITED
CALGARY ALBERTA CANADA

PROJECT			
TITLE	FIGURE 3 **CUTBANK** GATHERING SYSTEM		
DRAWN BY BCVW	DATE 81 08 24	DRAWING No. A-CUT-505-06	REV 1
CHECKED BY	SCALE NOT TO SCALE		

This use of the "corridor" concept was to minimize the number of new rights-of-way that would be prepared for this project. The concept was readily endorsed by Alberta Forest Service, Fish and Wildlife and Environment.

Throughout, Dome maintained close liaison with these companies to ensure that the corridor route selected by Dome was compatible with their routing plans. During planning, consideration was given to the width of this corridor. Normally Dome requires a minimum 15 m wide right-of-way to construct a gathering system. NOVA normally requires a minimum of 23 m and Alberta Power 10 m. It was decided that all these widths could be reduced somewhat if each company was able to use the work space on the other rights-of-way.

In the utility corridor (Cutbank River gas plant to SW 1/4 21-67-7 W6M) NOVA's easement was only 18 m but it was agreed they could use 5 m of Alberta Power's right-of-way for work room. Dome's and Peace's right-of-way was 24 m on which Alberta Power had a 9 m easement. In the corridor with Dome, Peace and Alberta Power (SW 1/4 21-72-7 W6M to NW 1/4 32-62-6 W6M), the right-of-way was 35 m wide of which Dome and Peace had an 18 m common right-of-way and Alberta Power had a 10 m right-of-way with the option to acquire 7 m for additional space. In the corridor with Dome and Alberta Power (Alberta Power substation to NW 1/4 33-62-6 W6M), the right-of-way was 25 m of which Dome had a 15 m wide right-of-way and Alberta Power's had a 10 m wide right-of-way. In the corridor with Dome and NOVA (N 1/2 62-7 W6M to 10-33-63-7 W6M), each had a 10 m wide right-of-way.

In general, the route requirements for Dome's and NOVA's pipelines in the utility corridor were similar. Alberta Power's criteria however were somewhat different. The greatest concern was that the number of bends in the corridor be minimized since for every bend they had to brace their line which would increase their costs considerably.

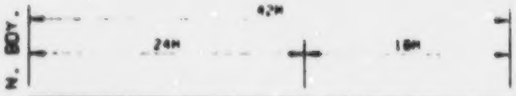
In routing the corridor, existing seismic lines or roads were examined to see if they were suitable. This is now normal practice within Dome and was well received by Forestry and Fish and Wildlife.

Initially, there were no direct roads from the plant west. One road, Nose Mountain Road, runs north of the Plant, then west eventually running south and east back to one of Dome's better wells. Since Drilling was proposing additional wells in the area, it was decided, in conjunction with Forestry and Fish and Wildlife, to construct a road with bridges across the Little Redrock and Redrock Creeks (Figure 3). In doing so OGE and Environmental Affairs worked closely with Drilling and government agencies to select the best location for both the road and the pipeline. When the road was built in late 1982, a 100 m wide right-of-way was cleared and graded for use by both the road and the pipeline. In allowing Dome to construct this road, Dome ensured Forestry that there would be no access on the Nose Mountain Road between November and May.

As well, we avoided any areas known to be critical wildlife areas, steep and unstable slopes and recreational areas. There were no archaeological concerns.

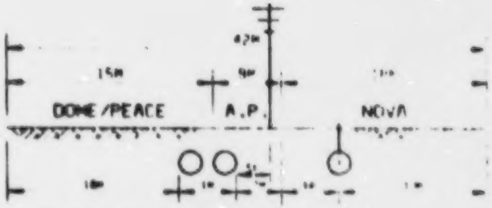
FIGURE 4

CUTBANK PLANT TO S.W.1/4 SEC 21-62-7



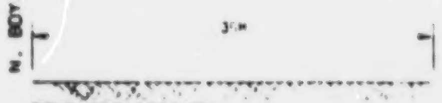
DOME APPLICATION:
24M R.O.W. INCLUDING
15M JOINT OWNERSHIP
PEACE PIPE AND 9M
ALBERTA POWER EASEMENT.

NOVA APPLICATION:
18M R.O.W. + 5M
WORKING SPACE ON
DOME APPLICATION.

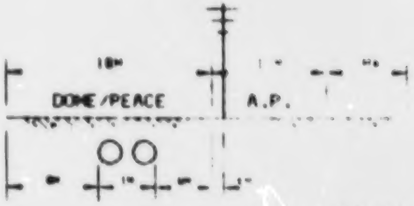


NOTE: POWER POLES MUST BE 5M MIN.
FROM EDGE OF PIPE DITCH.

S.W.1/4 SEC 21-62-7 TO N.W.1/4 SEC 33-62-6

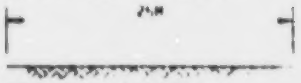


DOME APPLICATION:
35M R.O.W. INCLUDING 10M ALBERTA
POWER EASEMENT AND 15M JOINT OWNERSHIP
WITH PEACE PIPE.

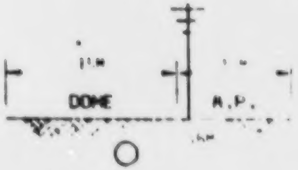


* ADDITIONAL TREE FALL
MAY BE TAKEN IF REQUIRED

A.P. SUB STN. TO N.W.1/4 SEC 33-62-6



DOME APPLICATION:
25M R.O.W. INCLUDING 10M
EASEMENT TO ALBERTA POWER.



* ADDITIONAL TREE FALL
MAY BE TAKEN IF REQUIRED

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ISSUED FOR INFORMATION	RMK	81/10/23
ISSUED FOR BID	RMK	81/10/29
ISSUED FOR CONSTRUCTION	RMK	81/12/08
REVISED PIPE LOCATION	RMK	82/02/01

DOME PETROLEUM LIMITED

CUTBANK

CUTBANK UTILITY CORRIDOR
PROPOSED SPACING

NONE

T-CUT-192-02

One concern of Fish and Wildlife was that of the impact of construction on fisheries. To assist in our selection of major crossing locations, a geotechnical survey was undertaken. As well, a fish survey was done to determine the fish species present in the watercourse. The main species identified were Arctic Grayling and Dolly Varden. The presence of these two species required considerable discussion with Fish and Wildlife on our crossing procedures and timing. Since there was no evidence of Dolly Varden at any of our crossings and because we were planning winter construction, we were allowed to use the "wet crossing" method for pipe installations. However, because of fisheries concerns, it was agreed by Dome, NOVA and Alberta Power that bridges would be built over in corridors to prevent fording of streams.

Finally, because the area is within Proctor and Gamble's management area, constant liaison was maintained with them concerning our proposed route. One major change in the corridor occurred as a result of Proctor and Gamble's concern that it would be traversing blocks of trees scheduled for cutting. Consequently a realignment of the corridor was made to minimize interference with their operations.

Problems Encountered During Construction

As with any major project, problems are anticipated but hopefully through proper planning can be eliminated or at least minimized. This project was no different. Although problems did occur, some of which were not anticipated, most were resolved and overall construction went well. What follows is a review of the major problems which occurred in the corridor. Some of these were identified during planning, others were not.

1. Scheduling Construction

Perhaps the most difficult aspect of the planning process was determining the logistics of construction in each of the corridors but particularly in the utility corridor. It was not reasonable to consider all three companies constructing in the corridor at once. Consequently, a schedule was established with NOVA commencing construction from the plant east, then Dome would start from the east and work west towards the plant and Alberta Power would follow Dome working east.

This schedule, however, was contingent upon all companies receiving regulatory approvals at the same time. Since each company was submitting its own application, it was difficult to finalize the construction schedule. Originally, NOVA was to have commenced clearing on the utility corridor in December, 1981, but did not begin until January, 1982 because of delays in receiving their approvals. This delay resulted in delays for the other companies and additional problems.

2. Clearing

Alberta Forest Service indicated that they wanted one contractor to clear the utility corridor. Unfortunately, by the time this became known to Dome and NOVA, both had gone out to bid for construction and as part of the bid were requesting a price to clear their portion of the right-of-way. As well, both companies felt the use of one contractor to clear the right-of-way would be difficult to do since it was likely that each would receive approvals at different times. Consequently, Dome and NOVA agreed to use common landing areas but separate clearing contractors. However, minor problems did occur during clearing when one contractor found landing areas unsuitable for him and established new ones. As well, since clearing began at different times and construction was in various stages, some of the decks of salvaged timber were never removed.

3. Construction Techniques

Another problem which occurred was the different construction techniques of each company.

Each company had its own construction specifications which were not necessarily compatible and in some cases sufficiently different that they created problems. For example, NOVA was constructing a 16-inch line and Dome's two lines, 8-inch and 4-inch lines in a common ditch. With the larger line, NOVA requires more grading and had larger berms which often sloughed onto Alberta Power's right-of-way. Since NOVA was delayed in starting construction, this caused problems with Alberta Power's installation of their poles.

4. Contractors

During construction, NOVA used a union contractor and Dome a non-union contractor and both companies perceived the potential problems of each working side by side. Although the schedule was originally set up to minimize both contractors working within the utility corridor at the same time, the change in schedule resulted in the contractors working side by side and minor conflicts did arise.

5. Roads

Although the corridor concept is accepted for linear developments, paralleling an existing road with pipelines may not always be the best route. Another problem identified during planning was that of using Proctor and Gamble's roads. Since winter is the major hauling period, care had to be taken to minimize conflict between logging trucks and pipeline construction vehicles.

The Dome/NOVA corridor running alongside Proctor and Gamble's north road to the Cutbank river was kept to a minimum width at the request of Forestry. Consequently, the road became part of the working area which created a safety hazard for both logging and construction vehicles. As well, if any road upgrading occurs, pipe relocation may be required.

6. Water Crossings

To minimize the impact of pipelining through the streams, Forestry and Fish and Wildlife required that a bridge be built across each stream. Fording was not to be permitted. Problems arose when at least one of the bridges installed by Dome was not suitable for NOVA's needs. The approach to the bridge was too steep for NOVA to get down with its longer lengths of pipe joints. Consequently, an additional bridge had to be constructed. As well, occasionally a bridge became unaccessible due to an open trench on large spoil piles blocking access.

7. Clean-Up

As part of clean-up, erosion control diversion berms were to be placed on steep slopes across the utility corridor. During the planning stage it was agreed that these berms would be located during clean-up. However, a problem arose when Dome was completing clean-up and NOVA was still ditching or backfilling. Dome was only able to build partial berms with the hope that NOVA would continue to run them across the right-of-way.

In the planning stages it was agreed that one company would reseed and fertilize the right-of-way and backcharge the other for its portion. However, with changes in construction schedules, this became impossible since Dome finished its construction before NOVA. Consequently, Dome only seeded and fertilized Alberta Power and its right-of-way and left NOVA to do its own when it completed its construction. Although not a major concern, the mixes used by each company were different.

8. Permits

You will recall that Dome built the liquids sales line for Peace Pipe and laid it in a common ditch with Dome's gathering line. Confusion occurred when during construction another pipeline was hit and damaged. Both companies were unaware of the line and did not have the necessary crossing approvals. Each thought the other had obtained the necessary crossing approvals.

Problems During Operation

To date no serious problems have been encountered on either the utility corridor or the other corridors. Minor erosion and poor revegetation have occurred in localized areas but have been remedied by each company.

Potential problems do exist though; Dome, NOVA and Alberta Power all have different requirements for maintaining their rights-of-way and this could result in a less than uniform looking right-of-way.

Another concern is if either Peace Pipe Line or Dome must do work on their pipeline, considerable care must be taken to ensure that the other company's pipeline, located in the same ditch, will not be damaged.

On the other corridors another potential problem exists since most parallel roads if any road upgrading is required costly pipe replacements may be required.

Recommendations

Overall, all the companies and the government agencies are pleased with the final result of the utility corridor and other corridors. It is obvious that the considerable planning between companies and government agencies was successful in eliminating or at least minimizing the problems. However, the following additional things could have been done to reduce further some of the problems that occurred:

For the most part, communication between all parties involved during the planning stage was good. Unfortunately, communication during construction was not as good. It broke down between companies, sometimes within companies, between contractors and between companies and government. Both Fish and Wildlife and Forestry indicated that at times they had difficulty in knowing who to contact. It could have been improved if a committee had been set up with representatives from each company to deal with specific problems.

In future, it would be preferrable not to have three companies working on the same right-of-way at the same time. This caused considerable delays and problems during construction.

When bridges are to be constructed across creeks, it would be preferrable to have the company using the larger equipment (in this case NOVA) to construct first and build bridges capable of meeting their needs.

Some problems probably could have been eliminated if a common clearing contractor had been used. However, to do so companies need to know government requirements early in the planning stages in order to accommodate such requests.

In future, forestry companies should make their logging plans better known. During route selection, Dome was often requested to change their route to follow roads in order to avoid conflict with Proctor & Gamble's future logging programs. Dome complied only to find the cutblocks cleared the following year.

As well, if companies know they are planning to construct a corridor, they should provide sufficient notice to the logging company so that the logging company could consider doing the clearing.

In all, construction went quite well, considering the complexities of it. The value of a good selection process minimized the number of problems with government and more importantly reduced the environmental impact of construction.

WILDLIFE DATA ISSUES IN THE ROUTING OF ENERGY CORRIDORS

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ABSTRACT

In the past, wildlife was largely ignored by utilities when selecting routes for energy transport facilities. This attitude has changed drastically during the last 20 years and the outcome has been to focus on species with high socioeconomic values in corridor selection studies. The objective of this overview paper is to discuss selected data-related aspects of the wildlife issue in routing energy corridors. The first section of the paper will discuss selected impacts created on wildlife by energy corridors and the role of corridors in shaping animal communities. The second part of the paper will address the wildlife data issue through the following topics: critical habitat, key species, loss of wildlife by small increment and experimental vs descriptive approaches. The third section of the paper will focus on the difficulties of gathering proper data to make predictions concerning wildlife and the role of management in route selection and right-of-way maintenance. Finally, conclusions will be formulated concerning the importance of wildlife issues in relation to other biophysical constraints in selecting routes for energy corridors.

INTRODUCTION

Energy and transportation corridors have affected wildlife since the early settlement of North-America and yet, historically wildlife issues have not played an important role in the planning of these facilities. Matthiessen (1964) gives a vivid account of the role that the construction of the first main transcontinental rail lines played in the demise of the buffalo (Bison bison). It is only during the last 20 years that increased attention has been paid to wildlife in corridor and route selection studies and the vast majority of these studies focused on species with high socioeconomic values such as ungulates, furbearers, waterfowl and endangered species.

The integration of wildlife issues in the planning process was difficult for two main reasons. The first was that the scientific literature was not conclusive on the benefits and disadvantages of rights-of-way (ROWs) on wildlife species or animal communities. The second was that wildlife was perceived very differently by various people, public agencies or disciplines and thus wildlife was often arbitrarily given a very different level of importance from one route selection study to another.

The objective of this overview paper is to discuss selected data-related aspects of the wildlife issue in the selection of energy corridors and ultimately the routing of the ROWs themselves. The discussion will address the following issues: 1) repercussions of ROWs on wildlife and animal communities, concepts, methodologies and approaches used to conduct the wildlife analysis in route selection, 2) the role of management, and finally 3) the importance of wildlife issues in the selection of corridors and routes for energy transportation.

REPERCUSSIONS AND CONTRAINTS

Rights-of-way and their associated structures can affect wild animals directly through collisions or indirectly through habitat modification. A priori one would expect that the greatest impacts on wildlife would result from large scale habitat modifications especially those which involve the clearing of ROWs through the forested environment. From a data point of view it is easier to collect and manipulate habitat data than it is animal data therefore it has been more common to analyze the wildlife issue from the habitat standpoint. Direct repercussions on animals on the other hand are more difficult to forecast but they have been shown to be numerous in retrospective studies and thus greater efforts are needed toward collecting the proper data to make valid predictions. The following are a selection of demonstrated impacts which show the difficulty of choosing the suitable data base for the impact assessment of ROWs on wildlife.

Animal aggregations

Dense aggregrations of animals or migrating populations can be extremely vulnerable to serious losses due to traffic or structures. Klein (1971) reported high mortality of reindeer (Rangifer tarandus) on roads and railroads, especially in winter. Allen and McCullough (1976) and Pugiisi et al (1974) respectively reported heavy white-tailed deer (Odocoileus virginianus) mortality on Michigan and Pennsylvania highways, while Grenier (1974) estimated the highway moose (Alces alces) kill at 15-20 per cent of the adjacent population in a Quebec park. Davis (1940) reported on the highway-related mortality of medium-sized mammals in Texas. Massive roadkills of amphibians on wet warm spring or early fall evenings are difficult to document in the literature (van Gelder 1973; Moore 1954; Carpenter and Delzell 1951), but occasionally anecdotal information can be revealing. For instance Bider (unpub. data) has observed a kill of 500 leopard frogs (Rana pipiens) during a 3-hour migration on 1 km of farm road adjacent to a river hibernaculum in southern Quebec. In Switzerland, some mountain roads are temporarily closed during amphibian migration. Under certain conditions (e.g. partial darkness, fog), powerline structures such as towers, conductors and ground wires can inflict appreciable losses to bird populations (Anderson 1978; Blokpoel and Haich 1976; Stout and Cornwell 1976; Boeker and Nickerson 1975; Scott _et al_ 1972; Sieyfried 1972; Cornwell and Hochbaum 1971; Ogilvie 1967; Stoddard and Norris 1967).

Rights-of-way structures are sometimes used to advantage by wildlife. Bridges, towers and poles are often used by wildlife for nesting sites (Bridges and McConnon 1981; Gilmer and Wiehe 1977; Stahlecker and Griese 1979; Prevost _et al_ 1978). Some highway interchange overpasses have been shown to harbour densities of woodchucks (_Marmota monax_) which were several fold higher than those found in adjacent agricultural areas (Doucet _et al_ 1974). Railroad and highway ROWs can be conducive to waterfowl nesting (Voorhees and Cassel 1980; Oetting and Cassel 1971; Page and Cassell 1971).

Animal communities

Changes in the structure of animal communities following the development or maintenance of ROWs have been discussed in some studies. Doucet and Bider (1982) showed that most forest species except amphibians reduced their activity in a newly developed ROW and Bramwell and Bider (1981) reported the same phenomenon following a defoliation experiment in a ROW. As the early stages of vegetation develop in powerline ROWs, pioneer small mammal communities develop (Adams and Geis 1981; Schreiber _et al_ 1976). As the brush community develops, bird species richness increases in ROWs (Bramble and Byrnes 1984; Chasko and Gates 1982; Meyers and Provost 1981).

The increased productivity and higher availability of preys in ROWs could result in greater predation intensity. Ladino (1980) reported higher activity for mammalian and reptilian predators in powerline ROWs. Several studies have reported greater animal activity at the forest edge (Wegner and Merrian 1979; Doucet 1975; Bider 1968). ROWs constitute long double ecotones and Gates and Lyzel (1978) have shown that this concentrates nests, producing an ecological trap where eggs and youngs are extremely vulnerable to predators.

Complete isolation of populations by the implantation of a ROW has never been demonstrated. Doucet _et al_ (1981), Lamothe and Dupuy (1982) and Willey and Marion (1980) have all reported deer crossing powerline ROWs in winter. Doucet and Brown (1983), Adams and Geis (1981) Schreiber and Graves (1977) and Schrieber _et al_ (1976) observed small mammals crossing ROWs in winter and summer. However, Joyal _et al_ (1983) and Doucet _et al_ (1981) have respectively shown that under given conditions, moose and deer crossings were reduced in ROWs during winter. Oxley _et al_ (1974) have shown that white-footed mice (_Peromyscus leucopus_) and chipmunks (_Tamias striatus_) failed to cross a 90 m wide roadway. Finally, Doucet and Brown (1983) found marked differences in hare (_Lepus americanus_) activity, during a population peak, in the adjacent woods on each side of a 30 m wide ROW.

Dispersal

Dispersal of plants and animals have been facilitated by ROWs. Huey (1941) was one of the first to report such a range extension for pocket gopers (Thomonys) in Arizona. Getz et al (1978) showed that field voles (Microtus pennsylvanicus) used roadways as dispersal routes. The presence of field voles in cleared ROWs in forested areas and the presence of grassland bird species (Chasko and Gates, 1983) indicate that animals have the potential to disperse in ROWs. This potential for dispersal brings up two important points. One, the biogeographical concept of saltatorial dispersal from one habitat patch to another could well be a phenomenon taking place in a cleared ROW. The second point was discussed by Schrieber et al (1976) and is related to the spread of diseases by animals such as rodents expanding their range through dispersal in established transport and energy ROWs.

Indirect impacts

The last group of impacts are those that are long termed or resulting indirectly from the implantation of a ROW. The Newfoundland railroad was completed at the turn of the century and it ran through the migration route of the main caribou herd. Hunters quickly adjusted to hunt the caribou as they crossed the ROW and by 1925 this scheme had largely contributed to the demise of the 40 000 caribou herd (Bergerud 1983). Deer and moose declines in Quebec in the 60's have been correlated to excessive hunting in areas where access was facilitated by the development of new highways (Bider and Pimlott 1973). The forecasting of long-term and/or indirectly induced changes in wildlife populations is an issue which deserves serious considerations in route and corridor planning.

CONCEPTS, CRITERIA AND APPROACHES

Critical habitat

Wildlife species need a habitat mosaic which enables them to feed, breed, raise young and rest. It is recognized however that some habitat components are more important than others in time and space. This has facilitated the adoption of the concept of critical habitat in route selection studies. Critical habitat remains an ill-defined concept; it has been variously interpreted as habitat which: 1) harbours a high diversity of life forms (e.g. marshlands), 2) fulfills a specific seasonal need for a given species (e.g. winter yards for white-tailed deer), 3) provides a fragile and/or limited refuge to a rare or endangered species, and 4) fulfills some intermediary function in the biology of a given species (e.g. migration routes of caribou).

Despite some shortcomings, the concept of critical habitat remains valid but it needs clarification and refinement. The central problem is the fact that it is difficult to recognize critical habitat without proper information. Habitat evaluation and mapped results have been lagging at scales appropriate for planners. The maps produced by ARDA for example were often inadequate planning tools because of poor resolution, lack of coverage or incomplete wildlife information. This was demonstrated during the recent routing of high voltage transmission lines in Quebec where several existing deer yards failed to appear on the ARDA maps for ungulate potential. Yet, in some areas, the ARDA analysis remains the best overall mapped information available. The next step is to seek information from the regional level; a slow process under the best circumstances, especially if it requires additional field surveys. There are efforts underway which should improve this situation. For instance the Canadian Committee on Ecological Land Classification has a wildlife working group which is developing appropriate methodologies and format for habitat mapping (Taylor 1979). Hounsell and Risley (1982) have developed a habitat classification system to predict the effects of powerline ROWs on wildlife. In Quebec, the Ministry of Leisure, Fish and Game has been concerned about wildlife habitat and it is striving to give legal status and protection to defined and identified critical habitats (Sarrazin 1983). Results of these efforts should improve the planning process in relation to wildlife habitats because planners will have access to organized information and guidelines (e.g. maps, laws) concerning valued wildlife habitat. However it appears that planners will be left with certain decisions concerning priority critical habitats in conflicting situations.

Key species

In the majority of planning studies, the wildlife analysis is often limited to a few so-called socioeconomically important or key species. This approach raises two important concerns. The first one is that key species means different things to different people. For instance it could be an endangered species or a species that plays a dominant role in the evolution of the structure of the animal community. There is no reason why wolves, beavers, robins or bullfrogs cannot qualify under given circumstances. But the question remains as to who and what criteria should decide which are the key species in a given route selection study. The second concern is that the soundness of determining a priori that some species are more important than others in the ecosystem is a highly questionable practice, whatever the scale of values used. Elton (1927) considered arctic copepods as key industry animals and Fianka (1983) and Paine (1966) defined keystone predators. Although these studies suggested that some species are dominant in shaping the structure of animal communities, in general few ecological studies have supported the concept that some organisms are more important than others in ecosystems. Indeed the holistic approach embraced by most ecologists makes such distinctions of importance highly dubious.

Losses by small increment

By definitions, ROWs are narrow strips and this has promoted the belief that site-specific impacts were of little consequence (with a few exceptions: e.g. pipeline spill risks and caribou migration disruption in the north). Thus the planning process often considers that only a small fraction of a given habitat (e.g. marsh, roost, deer yard) is lost when bisected by a ROW and that most animals can relocate outside the disturbed zone. Although this analysis can withstand regulative and public scrutiny in successive projects, small incremental losses could in the long run jeopardize the resource as a whole through direct or indirect repercussions such as those discussed earlier.

The same concept can be applied to wilderness. Wilderness has several definitions: it can represent vast areas of untouched land or innaccessible areas sometimes in a park or reserve and some wilderness areas are protected by legal status. We often attach the attribute pristine to wilderness and an acceptable definition of pristine is that which is unspoiled by modern tendencies. If we subscribe to the concept that some wilderness should remain free of large scale interventions, it follows that the routing of a ROW through such an area under the assumption that only a small fraction of the unit is lost should be opposed for two reasons. First, it destroys the very concept of a pristine area, if not wilderness itself. The second reason is related to losses by small increment. If a ROW can be routed through a wilderness area under the assumption that only a small fraction of habitat is touched, the same assumption can be carried out to successive route proposals in the same or different wilderness area and thus all wilderness areas could be encroached and jeopardized.

Experimental vs descriptive approach

It is unrealistic to attempt to develop a complete understanding of all ecosystems or animal communities in order to route an energy transport linear facility through the rural or forested environment. However, in order to consider the wildlife issue, it is imperative to have at least a preliminary understanding of the ecological relationships which various wildlife species maintain with each other and with their habitat. To predict the repercussions of ROWs on wildlife a choice usually has to be made between a descriptive approach and an experimental approach. The descriptive approach is often speculative and fails to yield the data required to determine the repercussions concerning reproduction, feeding, behaviour, predation, dispersal and ultimate fate of wildlife populations under consideration. On the other hand, the use of experimentation and scientific methods has been slow and at times inconclusive in producing information helpful to planners. Let us examine this weakness in relation to white-tailed deer, a "hot species" in many ROW planning studies in the northeast. The wildlife literature (Halls 1978; Dasmann 1971 and Hosley 1956) suggests the creation of forest clearings to produce pioneer vegetation and provide winter browse for deer. Bramble and Byrnes (1974, 1981) observed increases in deer browse in powerline ROWs in Pennsylvania. These results, although useful in route selection in deer range at large, become of dubious value in northern deer yards where cover is so critical. A five year study (Doucet et al 1981) in such a yard showed that deer were less active in a 30 m wide powerline ROW than in the adjacent forest in the winter and the authors suggested that deer yards should be avoided by energy transportation ROWs. However, a recent study (Doucet and Brown 1983) conducted in the same yard showed that deer spent considerable time browsing in the ROW during winter. Thus after 10 years of research the results are still inconclusive concerning the trade-off between the loss of cover and the gain in food production in relation to ROWs in northern deer yards. The magnitude of this trade-off is also likely to change for each yard depending upon winter severity and annual population levels within a yard. This one-species scenario shows that there are cases where conclusions based on research data are of limited assistance to the corridor and route selection process.

Several authors (Beanlands and Duinker 1983; Romesberg 1981; Green 1979; and Ward 1978) have deplored the limited use of scientific methods in environmental studies. These authors, however, pointed out the difficulties of conducting control-treatment studies during the preliminary impact assessments of a proposed project. Beanlands and Duinker (1983) have suggested the use of an ecological perspective to the biological components of impact studies. This approach would need to use some unifying ecological processes such as eutrophication, or nutrient cycling as a negotiable currency. In general, studies on whole animal communities are difficult to conduct because of multi-technique sampling problems. Studies by Bramwell and Bider (1981), Ledino (1980) and Doucet and Bider (1982) using sand transects as a technique and animal activity as a currency have shown the short-term effects of cleared powerline ROWs on terrestrial animal communities but the long term effects remain largely unknown.

We finally believe that experimental research on representative problems would evaluate the legitimacy of several concerns related to wildlife and ROWs and the outcome would increase the efficiency of the planning process. Although the impractibility of conducting many large scale treatment-control studies is recognized, it seems that a potential solution to this difficulty is to implement a few representative long-term studies and to establish monitoring for a number of typical projects (Beanlands and Duinker 1983). This approach would eventually generate a data base from which to make predictions and suggest mitigations.

Another approach is to create experimental reaches of energy and transportation ROWs for the specific purpose of investigating repercussions on wildlife. These special sections could be submitted to treatment-control experiments and could contribute to ecological science and improve the accuracy of predictions for corridor planning.

Results of long-term studies may turn out to be the necessary information for efficient planning in relation to wildlife and ROWs. How long should those studies be is a difficult question to answer but in order to obtain adequate data to make predictions possible concerning wildlife populations and related processes, study specifications should consider for instance the cyclical nature of several wildlife populations and ROW maintenance cycles.

DATA REQUIREMENTS

There are several types of data required in order to integrate wildlife issues in the route selection process. Two specific types of data are: 1) those related to impacts or constraints associated to routing and ROW implantation, and 2) those data required to determine the effects of ROW maintenance activities on wildlife (e.g. timing of work, types of machinery, labour force, phytocides, fire, etc.). The approach has been that baseline data will provide sufficient ecological understanding to permit the formulation of predictions. Although this sounds logical, the problem lies in the fact that the expression baseline data is much too vague in time, space and scope. The interpretation of this concept by environmental specialists in a permit procurement system has been to collect a minimum of data to satisfy the guidelines. Many of these data collections were of limited use in successive route selection studies mainly because very few of these studies included systematic long-term monitoring (Beanlands and Duinker 1983). In addition, very few of these analyses concerned themselves with indirect impacts. Consequently there is a paucity of good representative studies which could serve as backbone in new route selection studies. The post-construction monitoring often presents a non-expansive and practical way of producing before and after type data (Beanlands and Duinker 1983). Certainly this approach should provide pertinent wildlife data and conclusions applicable to future routings of linear energy facilities.

As stated earlier, an improvement in approach would be attained through rigorous experimental studies on specific wildlife problems related to ROW implantation or maintenance. Such studies, using scientific methods, would consider topics like habitat management, edge effect, plant and animal communities, animal activity, predation, competition, dispersal and safety hazards, in order to develop the necessary data to make predictions concerning impacts of ROWs on wildlife. Efforts in that direction have produced useful preliminary results concerning animal activity (Chasko and Gates 1982; Bramwell and Bider 1981; Doucet *et al* 1981, Ladino 1980), but research must be continued to determine the true impact mosaic of ROWs on wildlife. Finally, at some point in time, research will have to address the complex problem of indirect impacts.

MANAGEMENT

Habitat management

Most wildlife management ventures to date in energy transportation ROWs were directed at habitat modifications. It is quite amazing how management efforts get the go ahead despite flagrant lack of data concerning the wildlife issue. The routing of ROWs creates a spatio-temporal trade-off where some species benefit while others are stressed and unless we understand the magnitude of this trade-off, it remains extremely difficult to make enlighted management decisions concerning wildlife. There is considerable general and somewhat technical information on the management of ROWs for fish and wildlife (e.g. Leedy and Adams 1982; Galvin *et al* 1979, and Meyers and Provost 1981). Although these reports and several others are more concerned with habitat "grooming" than habitat management they indicate that at times, and through positive management decisions, a certain compatibility can be achieved between wildlife requisites and the routing of ROWs. Certainly, to date, there is available knowledge on some specific wildlife concerns which can be integrated in the planning process in order to address some specific wildlife issues and reduce the impact and sometimes possibly improve the fate of some wildlife species. In the northeast for example, few species arouse public concerns as much as white-tailed deer. These ungulates congregate in traditional winter yards which represent critical habitat for the survival of the deer populations. Under these circumstances, one would consider yards to be major constraints to corridor routing. However a deer yard can be broken into two major components which are cover and food: and while the clearing of coniferous cover to route an energy facility should not be considered, deciduous stands on the other hand can present a viable alternative under specific circumstances. Textbooks on yard management (e.g. Dasmann 1971) suggest to rejuvenate climax deciduous stands to produce deer browse, thus the routing of energy transportation ROWs in such mature deciduous stands within a deer yard appears feasible. Once this concept is accepted it becomes possible to formulate objectively and integrate the details of a management plan into a project (e.g. clearing-by-small-blocks rotation). A successful case has been reported (Lamothe and Dupuy 1982) in Quebec, where a twin 735 kV line was routed through an active deer yard. By locating the elevated towers in clearings practiced in deciduous and mixed stands and raising the conductors to spare coniferous stands, the loss of cover was minimized and deer were provided with quantities of browse from the slash of the original clearing which was carried out in the winter and browse produced by the new growth in successive years. Overall, it is possible that the project may have benefited deer. Unfortunately the long term monitoring of this project was not geared to determine the cover-browse trade-off and it remains difficult to determine the effect of the maintenance schedule on browse production and availability.

It is most important to emphasize that we can only proceed on a case by case basis and that all deer yards are not systematically suited for the routing of an energy transportation ROW. In addition, the routing of a ROW in a deer yard eliminates the wilderness characteristics which are sometimes attached to such habitats. Finally on a comparative scale, deer are certainly much better off to have a linear energy transport facility encroach their yards than a housing development. This kind of choice is not usually left to wildlifers and/or planners alone.

Management: a panacea

Habitat management should not be considered the cure-all for the various problems that ROWs present for wildlife populations. The management of ROWs for wildlife is a complex issue (Meyers and Provost 1981). The be effective, habitat management must be carried according to a set of objectives, otherwise the effects could amount to well- intentioned habitat "grooming". From a wildlife point of view, linear energy transportation facilities present three different sets of problems which are those associated with: 1) planning, 2) construction and, 3) operation and maintenance. The planning phase not only determines the route but it is also responsible for the formulation of guidelines and terms of references for the construction and operation phases. Thus communication is essential between these phases if management is to be successful. Since planning, construction and operation are carried out by different agencies or divisions within an agency, communication breakdowns start during the construction phase and often become complete during the operation and maintenance phase.

Certainly, decisions made concerning the routing and construction aspects can be called management decision but the decisions concerning the operation and maintenance of a ROW, in practice, are generally left to the proponent. The planning phase should consider the maintenance aspects of a ROW very seriously in relation to wildlife during a route selection study. This approach requires three important requisites. One, the terms of references for ROW habitat maintenance must remain extremely simple. Secondly, follow-up or monitoring programs must be put in place; such programs could be integrated in the overall ROW inspection program. Finally communications must be assured between the master plan responsibility levels and the field maintenance levels. Breakdowns at this latter stage are as easy to find as bulldozer operators.

ROLE OF WILDLIFE DATA IN CORRIDOR SELECTION

The route selection process must consider wildlife within an array of other biophysical constraints along with social values, costs and technical constraints. The importance of wildlife in such multidisciplinary approaches has been characterized by a roller coaster approach where wildlife issues played a very different role in various studies. Perhaps one reason for this is the willingness of the public to abandon their rights or interest in wildlife (Schoenfeld and Hendee 1978). When there is a conflict with other issues (e.g. forestry, agriculture) in a route selection study, often one can expect wildlife issues to play a secondary role under a lack of sustained public interest. On the other hand, several public groups are often most eager to add weight to other issues such as agriculture, forestry and recreation. Perhaps one reason for these issues gaining momentum during a study is the fact that they lend themselves to dependable predictions and forecast. For example, it is easier to determine that 200 ha versus 600 ha of agricultural land will be lost depending on the outcome of a route selection study where two alternatives are considered. Wildlife issues are usually not as clearly presented and perhaps the lack of adequate data, at times, can contribute to the ultimate demise of wildlife concerns in the corridor and route selection process. There are very few well informed voices which speak for wildlife in route selection studies and unless a species or habitat is legally protected, the level of constraint of the wildlife issue is greatly reduced. If the importance of wildlife issues is to be established from social values and national heritage points of view, this can only be achieved through better knowledge of the impacts of ROWs on wildlife communities.

CONCLUSION

Wildlife populations can be affected in many ways by linear energy transport facilities. These impacts can be short- or long-termed, direct or indirect, trivial or of great significance. An essential component of the planning and impact assessment processes is to make predictions. Unless you have a definite idea of: 1) which populations are present and at what time of the year they are most vulnerable to habitat modification, and 2) which ecological processes (e.g. predation) will be affected by a ROW, it becomes extremely difficult to make accurate predictions concerning the fate of these populations, their behaviour, dispersal and community structure, especially in a long-term perspective. The role of energy corridors in shaping animal communities represents a recent interest in the scientific community. It is obvious that some species will benefit while others will be disadvantaged and the trade-off presented by energy ROWs remains difficult to predict from the evidence available. Scientific research in this field is badly needed to provide the proper data to make accurate predictions concerning wildlife and route selection.

Research concerning habitat management in established ROWs could reduce constraints from the route selection process and at the same time improve the fate of wildlife populations occupying habitats which become bisected by energy transport linear facilities. The failure to adopt this course of action will result in a state of stagnation where each route selection will produce various quantities of descriptive wildlife data which will be of limited use to the route selection process and to management efforts.

The role of wildlife issues in corridor selection will be enhanced and simplified through more intensive research in that specific field of wildlife biology. Better overall evaluation and mapping of wildlife habitat (e.g. through improved resolution in remote sensing) will enable planners to recognize problems early in the corridor and route selection process. The maturing of the above considerations can only take place if planners and wildlife specialists maintain an open dialogue to ensure a realistic and favorable inclusion of wildlife issues in the route selection process. In the long run, this will make the route selection process easier, more conflict free and more efficient.

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METHODOLOGY FOR VISUAL RESOURCE EVALUATION IN TRANSMISSION LINE ENVIRONMENTAL IMPACT ASSESSMENT

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METHODOLOGY FOR VISUAL RESOURCE EVALUATION IN TRANSMISSION LINE ENVIRONMENTAL IMPACT ASSESSMENT

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ABSTRACT

The major thrust of visual analysis is to evaluate objectively certain aspects of terrain, vegetation and water resources which are perceived by people as having aesthetic value. Those aspects can also determine the degree to which various landscapes can accommodate development or disturbance.

The methodology is based on existing methods which utilize the concept of visual units to determine attractiveness, and employs the more tangible factors of landscape absorptive capability, a function of slope and vegetation/terrain types) and exposure to view to determine the anticipated level of visual impact.

Vertical and oblique photography, topographic maps and ground and aerial reconnaissance were used to map an area in northwestern British Columbia according to four landscape features; exposure to view, attractiveness, slope and vegetation/terrain type. Simple matrices use these features to determine the sensitivity of a mapped unit to visual impacts from linear developments.

1.0 INTRODUCTION

A proposed 500 kV transmission line between Terrace and Prince Rupert, British Columbia provided the opportunity for evaluating the area's visual resources as part of a multidisciplinary environmental assessment of the project.

The Terrace Prince-Rupert area is characterized by the rugged mountains and high precipitation of the Coast Range. The Skeena River is the main feature of the valley between the two cities, flowing among islands and river bars near Terrace, but broadening out toward its estuary near Prince Rupert.

The mountainsides are heavily forested in cedar, hemlock, spruce and fir. River flats are often dominated by black cottonwood, alder and willow. Logging clearcuts are common in the Skeena valley and tributary valleys.

The proposed transmission line would follow the Skeena valley for most of the distance from Terrace to Prince Rupert. Already in the valley are a gas pipeline, provincial highway, railway and a 287 kV transmission line which leaves space at a premium within the narrow valley bottom. The provincial highway is the only road link between Prince Rupert and the rest of British Columbia. It is also important as a scenic tourist route for passengers connecting with the B.C. or Alaska ferry system to or from the central part of the province.

The rugged attractiveness of the landscape and the heavy use of the highway by residents and tourists indicated that any new developments should acknowledge the importance of the visual resource and should minimize disturbance to the valley.

2.0 METHODOLOGY

The methodology employed to evaluate visual resources was based on Visual Resources for the Northeast Coalblock Area (R.M. Tetlow and S.R.J. Sheppard, 1977). It utilized the concept of visual units to determine attractiveness. The methodology was developed specifically for use in varied mountainous terrain. Two other concepts, landscape absorptive capability and exposure to view, are adapted from Cheekye to Dunsmuir 500 kV Transmission Line Route Selection Study (Beak Consultants Limited, 1979). These three concepts or factors were evaluated in attempt to define those aspects of the landscape which are perceived by people as having aesthetic value, as well as those aspects which determine the tolerance of various landscapes to linear development (Fig. 1).

3.0 FACTORS IN INVENTORY DATA ANALYSIS

The following three factors were measured using a combination of field and office methods. All factors were mapped as areas on 1:50 000 scale topographic maps (Map 1). For each area, a rating of high, moderate or low was assigned based on predetermined criteria. Criteria are detailed in Skeena-Rupert 500 kV Transmission Line Environmental and Socio-economic Assessment (B.C. Hydro, 1983) and shown in Tables 1, 2 and 3 of this paper.

(a) Attractiveness

To determine attractiveness, the study area was divided into visual units. Visual units are portions of the landscape enclosed by topographic features which bound an observer's field of view and assist him to form a unified impression of his surroundings. Within each of eight units, 20 factors related to landscape contrast, diversity of water form and landform, etc. were described and rated (Table 1). Visual units were delineated on topographic maps with the help of air photos and verified in the field.

(b) Exposure to View

Exposure to view was determined by both the degree of visibility of a landscape area and assumed expectations of viewers using the study area (Table 2). The visibility factor considered the number and proximity of viewpoints such as roads and residential or recreation areas within subunits of each visual unit. The viewer expectation factor took into account the degree of disturbance or alteration already present in the landscape.

(c) Landscape Absorptive Capability

The natural potential of landscapes to absorb or tolerate visual alteration arising from development can be called landscape absorptive capability. It is a product of the slope and the vegetation/terrain characteristics of an area (Table 3). Steep slopes and uniform vegetation cover will not "absorb" a transmission right-of-way as well as gentle slopes, undulating terrain and discontinuous vegetation patterns. Slopes were determined from topographic maps. Vegetation and terrain characteristics were gleaned from aerial photographs.

4.0 SENSITIVITY OR POTENTIAL IMPACT ANALYSIS

Attractiveness, exposure to view and landscape absorptive capability are all determinants of the sensitivity of a landscape to alteration. Sensitivity is a measure of the potential for alteration of the visual resource from its existing state due to development or disturbance. Where the existing landscape is in a natural undisturbed state, potential for alteration is much higher than if the landscape already harbours such developments as transmission lines, pipelines, logging and so on.

The landscapes with the highest visual sensitivities are those whose landscape absorptive capabilities are low, but whose exposure and attractiveness values are high. Steep forested slopes visible from the main highway, parks, or farms are considered highly sensitive for these reasons. Open water in visual units of high attractiveness and in areas visible from the highway is also considered highly sensitive.

Moderately sensitive areas exhibit various combinations of the factors discussed previously and are widespread throughout the study area.

Low sensitivity areas are usually relatively flat and not visible from roads or other viewpoints. Low attractiveness, highly absorptive discontinuous forest cover or existing development would also be contributing factors.

The study area map units were thus given sensitivity or potential impact ratings of high, moderate or low, dependent on the combination of factors they exhibited (Table 4, Map 1).

5.0 MITIGATION OPPORTUNITIES

The best way to avoid visual impacts is to locate the transmission route through low sensitivity areas. However, due to technical constraints or anticipated impacts on other resources, this is not always feasible.

Even if the transmission route crosses areas of high or moderate sensitivity, there are measures which can be taken to lessen impacts. The mitigative strategy should be to lessen the contrasts between the right-of-way and its surroundings so to reduce visibility of the transmission line.

Most mitigation measures must be site-specific. Those involving vegetation should be incorporated into a comprehensive vegetation management plan which would include clearing and maintenance provisions for fisheries and wildlife as well as visual resources. Some mitigative techniques are as follows:

1. Selective clearing of tall-growing species; feathering right-of-way edges so there is a gradual progression from low-growing vegetation near the centreline to tall growth at the edge.

2. Contouring right-of-way edges where no shrub growth exists to reduce the straight swath appearance. Undulating edges are most successfully used where natural topographic lines can be followed.

3. Retention and encouragement of low-growing vegetation.

4. Retention and establishment of vegetated buffer strips or screens adjacent near road, railroad, or water crossings and other viewpoints. Topping of trees in lieu of removal is a possibility at high visibility crossings.

5. Selective rather than broadcast herbicide applications.

6. Retention of tall-growing vegetation where there is no interference with conductors, e.g., in gullies or at the bases of hills.

7. Conforming access roads to land contours, using grading and drainage procedures which prevent erosion.

8. Use of the common corridor concept where more than one transmission line exists in a valley or visual unit. If lines of different voltage cross a slope, the higher voltage line should be on the low side to minimize clearing width and visibility.

9. Minimizing crossings of large water bodies. Failing that, minimizing span lengths using right angle crossings.

10. When paralleling a road within a valley, location of the transmission route upslope and on the same side as the road.

6.0 IMPACT ASSESSMENT

Criteria were established to determine what level of impacts would be anticipated on sensitive areas when various mitigation measures were applied (Table 5). On areas where no mitigation was possible, the impact rating remains the same as the sensitivity or potential impact rating. Map 1 shows the completed visual analysis for a portion of the proposed transmission route.

7.0 CONCLUSION

This methodology provides a framework for understanding and evaluating some important elements in the visual landscape. Because it requires as well as affords relatively detailed mapping and analysis, it is recommended primarily for assessment of those developments which are expected to cause significant change in areas which are highly valued for their existing natural landscapes.

TABLE 1

ATTRACTIVENESS - SCENIC DISTINCTION SCORES*[1]

	Visual Unit							
Scenic Factor*[2]	**Morse**	**Prudhomme**	**Rainbow**	**Green River**	**Lachmach**	**Skeena Estuary**	**Skeena Channels**	**Lakelse**
Spatial Vividness	7	24	8	8	24	24	30	2
Cross-Section Complexity	16	24	4	7	18	24	24	4
Cross-Section Proportion Index	12	12	6	30	30	30	30	30
Cross-Section Contrast	10	16	4	10	21	10	30	6
Linearity and Continuity	6	10	3	5	21	12	18	1
Skyline	10	12	5	7	24	18	12	5
Profile	9	18	8	13	16	16	24	5
Floor	12	16	12	12	16	24	30	5
Lakes: Extent and Character	30	24	12	10	2	0	2	10
Rivers: Extent and Character	0	3	3	8	5	12	12	6
Lakes: Shoreline Form	8	18	24	10	1	0	0	6
River: Shoreline Form	4	6	4	6	5	5	8	3
Water Setting	8	10	8	8	4	16	16	4
Setting Frequency	16	8	10	18	8	5	16	9
Falls and Rapids	2	3	2	3	3	0	4	4
Peaks	10	12	10	10	12	12	12	6
Snow and Ice	0	0	0	3	3	3	8	0
Vegetation Contrasts	2	5	4	8	10	7	24	6
Visual Unit Linkages	10	10	5	9	9	12	24	0
Impacts and Degrading Contrasts	3	7	6	8	4	7	7	0
Total Score	175	238	138	193	236	244	331	112
Adjusted Score*[1]	58	79	46	64	79	81	110	37
Attractiveness Rating*[3]	Mod.	Mod.	Mod.	Mod.	Mod.	High	High	Low
Map Designation	M	M	M	M	M	A	A	L

---

*[1] Scoring was done independently by three people, so the scores are cumulative. Scoring by each person was on a scale of 0 to 10 as described in Tetlow and Sheppard (1977). The adjusted scores are the total scores divided by three.

*[2] Explanations of these terms may be found in the reference noted above.

*[3] Ratings were given in accordance with Tetlow and Sheppard's (1977) scoring levels:

Low	0 to 39
Moderate	40 to 79
High	80 to 119
Very high	120 to 159
Outstanding	160 to 200

TABLE 2

EXPOSURE TO VIEW

Exposure Rating*[1]		Criteria
High (R)	-	Areas readily seen from viewpoints such as roads, railroads, recreation or residential areas.
	-	Expectations of viewers do not include development or disturbed landscapes.
Moderate (D)	-	Large areas seen from a long distance or small areas seen from a short distance.
	-	Expectations of viewers may include other than natural landscapes.
Low (O)	-	Areas seen occasionally from viewpoints.
Nil (-)	-	Areas never seen from viewpoints.

---

*[1] Letters in parantheses refer to map designations.

TABLE 3

LANDSCAPE ABSORPTIVE CAPABILITY

	Slope		
	Steep (S)	Intermediate (I)	Gentle (G)
Terrain/Vegetation Description	>30%	15 to 30%	<15%
Continuous uniform tree cover - either all deciduous, all coniferous or even mixture of both. No conspicuous terrain patterns. Open water. (U)	Low	Low	Moderate
Continuous but irregular tree cover (uneven ages or clumped species distribution). or Discontinuous tree cover with vertical terrain pattern (gullied slopes). (V)	Low	Moderate	Moderate
Discontinuous tree cover, terrain pattern horizontal or irregular. (Burn area, newly logged areas, bogs.) (T)	Moderate	High	High

Note: Letters in parantheses refer to map designations.

TABLE 4

CRITERIA FOR VISUAL SENSITIVITY RATINGS

Sensitivity Rating	Criteria
High	Areas with both high attractiveness and high exposure.
Moderate	Areas not included above with at least two of the following characteristics: moderate or low absorptive capability, moderate or high attractiveness, moderate or high exposure.
Low	All remaining areas.

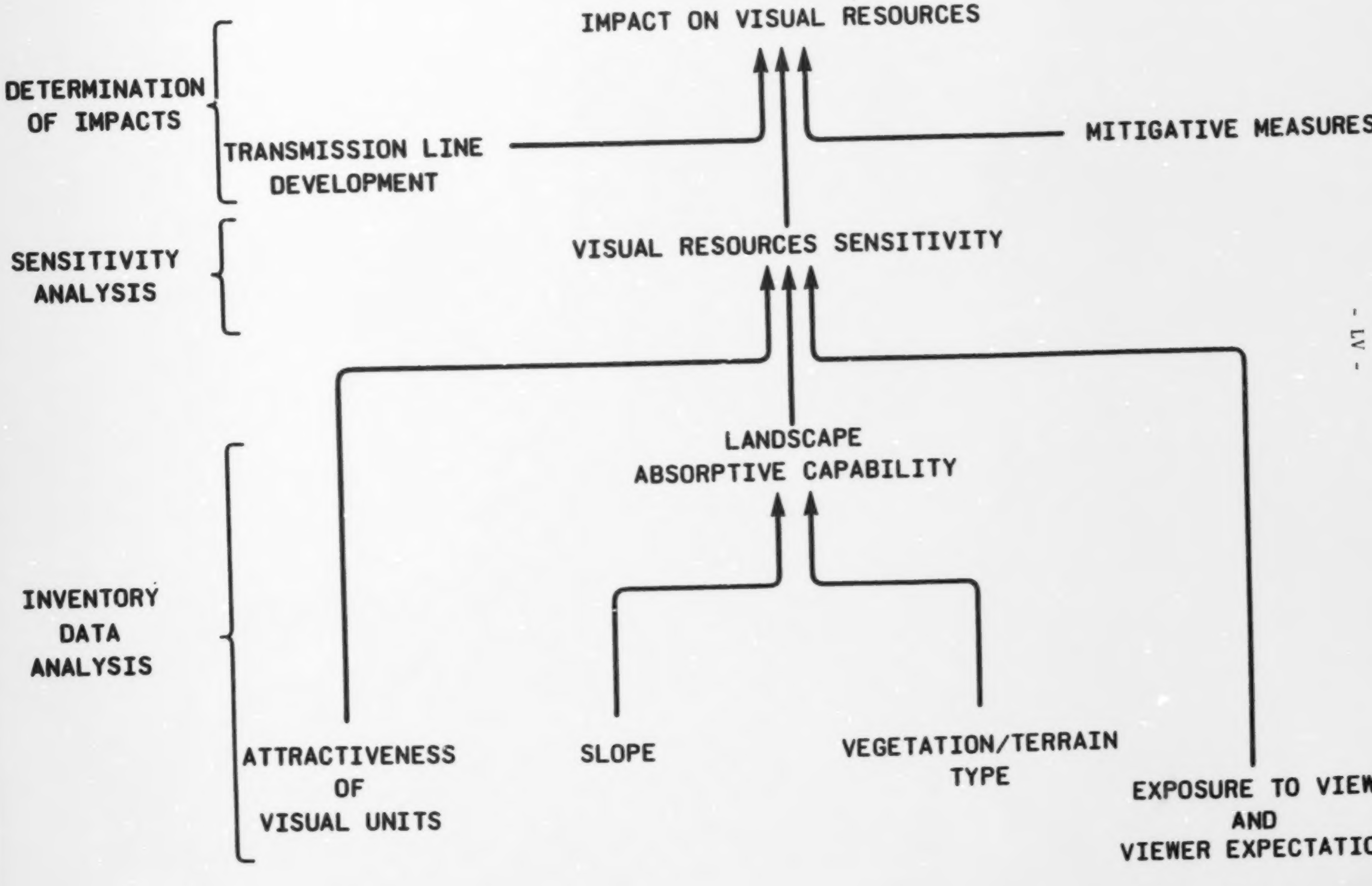
TABLE 5

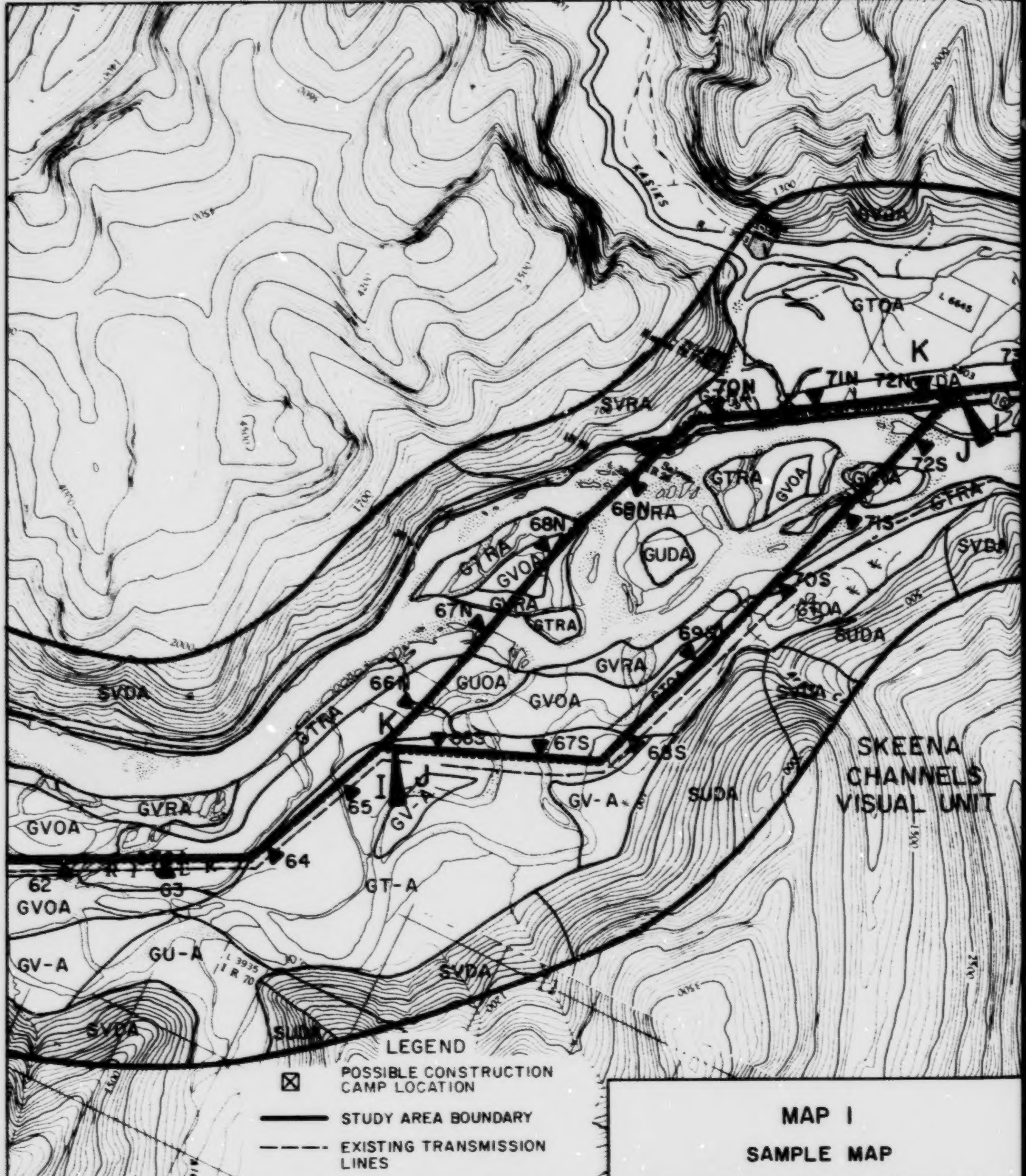
CRITERIA FOR DETERMINING VISUAL IMPACT RATINGS

Impact Rating	Criteria
High	High sensitivity areas where even with mitigation, visibility remains high and high scenic values would be permanently impaired.
Moderate	High sensitivity areas in which mitigation measures like screening, buffer strips and good vegetation management would reduce impacts to a moderate level. Also, areas where an existing transmission line makes the addition of a second one only a moderately disturbing change.
Low	Moderate sensitivity areas in which mitigation measures will reduce impacts or areas in which an additional transmission line will cause only a slight additional impact.

FIGURE I

METHODOLOGY FOR VISUAL ANALYSIS


DETERMINATION OF IMPACTS
SENSITIVITY ANALYSIS
INVENTORY DATA ANALYSIS
IMPACT ON VISUAL RESOURCES
TRANSMISSION LINE DEVELOPMENT
MITIGATIVE MEASURES
VISUAL RESOURCES SENSITIVITY
LANDSCAPE ABSORPTIVE CAPABILITY
ATTRACTIVENESS OF VISUAL UNITS
SLOPE
VEGETATION/TERRAIN TYPE
EXPOSURE TO VIEW AND VIEWER EXPECTATIO



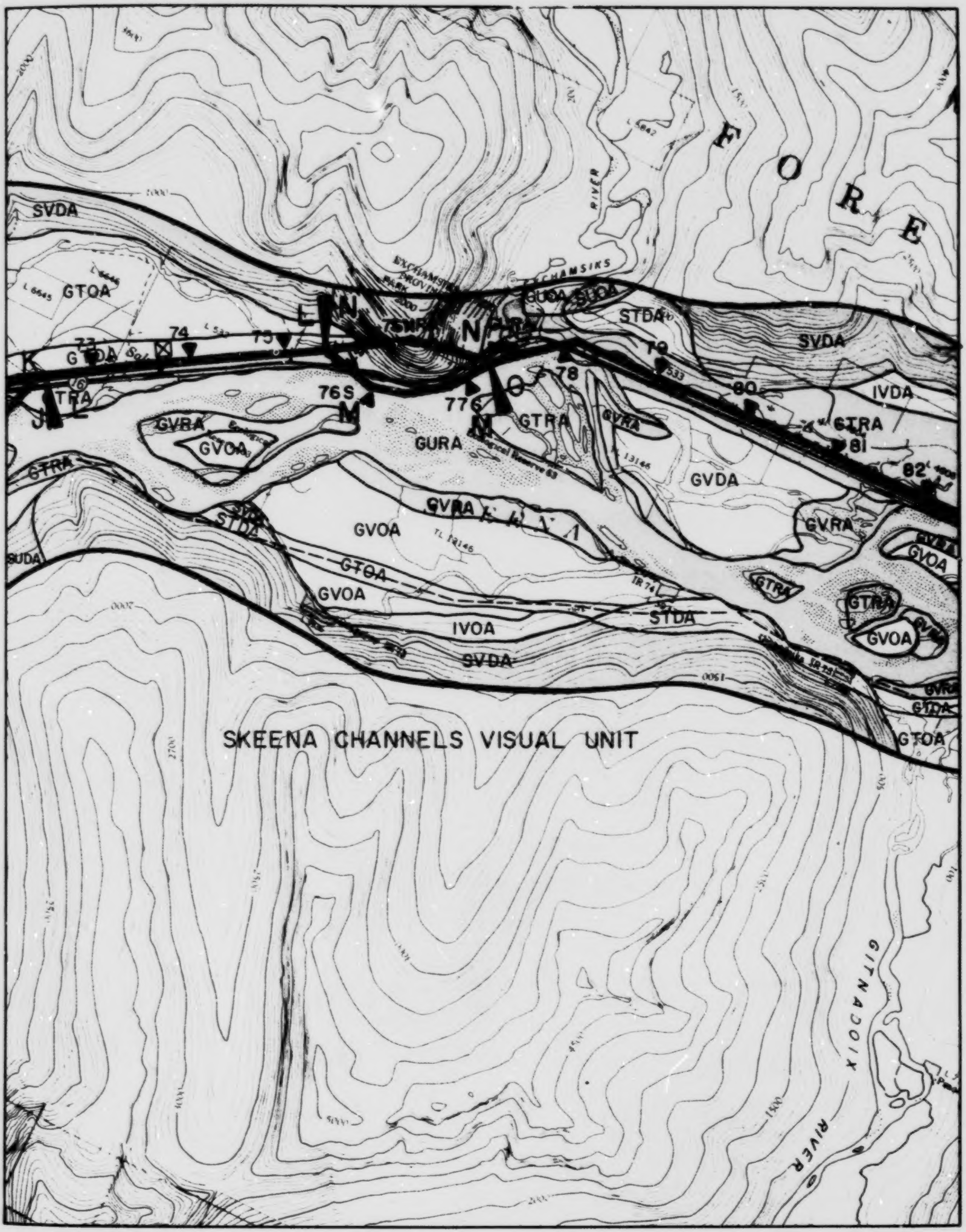
MAP I

SAMPLE MAP

COMPLETED VISUAL ANALYSIS

SCALE 1:50,000

LEGEND
☒ POSSIBLE CONSTRUCTION CAMP LOCATION
STUDY AREA BOUNDARY
EXISTING TRANSMISSION LINES
PROPOSED SKEENA-RUPERT 500 kV TRANSMISSION LINE
A B SEGMENT MARKERS
10S KILOMETRE MARKERS
1
0
1
2 km
SKEENA CHANNELS VISUAL UNIT
SVDA
GTOA
K
71N
72N
70N
SVRA
68N
GDRA
GTRA
GVOA
GUDA
72S
71S
70S
69S
67N
66N
GUOA
GVRA
66S
67S
68S
I
J
65
64
62
63
GT-A
GV-A
GU-A
SUDA
L 3935
I R 70
L 6645
KASIKS
2000
1300
1700
4000
3000
1500


F O R E
SVDA
GTOA
EXCHAMSIKS
SUOA
STDA
SVDA
IVDA
K
GTOA
73
74
75
76
L
N
O
76S
776
78
79
80
81
82
J
L
GTRA
M
GVRA
GVOA
GURA
GTRA
GVRA
GTRA
GVDA
GVRA
GVOA
GTRA
STDA
GVRA
GVOA
SUDA
GTOA
GVOA
IVOA
SVDA
STDA
GTRA
GVOA
GTRA
GVRA
GTDA
GTOA
SKEENA CHANNELS VISUAL UNIT
GITNADOIX
RIVER
RIVER

LEGEND

VISUAL RESOURCES

INVENTORY

SLOPE

S	STEEP, >30 PERCENT
I	INTERMEDIATE, 15-30 PERCENT
G	GENTLE, <15 PERCENT

TERRAIN/VEGETATION

U	UNIFORM, CONTINUOUS TREE COVER
V	CONTINUOUS BUT IRREGULAR TREE COVER OR DISCONTINUOUS TREE COVER WITH VERTICAL TERRAIN FEATURES
T	DISCONTINUOUS TREE COVER OTHER THAN ABOVE

EXPOSURE

R	READILY SEEN FROM ROADS OR OTHER VIEWPOINTS
D	SEEN FROM MODERATE DISTANCE AWAY
O	SEEN OCCASIONALLY
-	NOT SEEN

ATTRACTIVITY

A	HIGH ATTRACTIVITY
M	MODERATE ATTRACTIVITY
L	LOW ATTRACTIVITY

— — VISUAL UNIT BOUNDARIES

SENSITIVITY		IMPACT	
■	HIGH	━━━	HIGH
▨	MODERATE	━━━	MODERATE
	LOW	━━━	LOW

WORKSHOP SUMMARY

Session II "Elements of the Process"

Summary of Workshop Discussion

G. E. Beanlands

The working groups were asked to address a number of questions which arose from the submitted papers. In total, the groups discussed thirteen questions. The gist of the answers are presented in annotated fashion below:

1. Allocation of Responsibilities

(a) Question: Is more cooperation between governments and industry in route selection and siting desirable and how can it be achieved?

Answers:
- desirable up to a point, mostly in area of study design
- enhances common understanding
- there are potential conflicts of interest
- to some extent cooperation is hindered by adversarial review process
- need clear government policy in this regard

(b) Question: To what extent should government agencies share responsibility for collection of baseline data for route selection and siting?

Answers:
- government should focus on resource *management* responsibilities
- proponents should focus on specific project environmental *impacts*
- the distinction between the above two responsibilities is not always clear
- there is a potential for conflict of interest
- the degree of sharing of responsibilities is governed in part by agency mandates

(c) Question: Who should be responsible for deciding on trade-offs associated with alternative routes and sites?

Answers:
- ultimately government must decide (politicians)
- proponent should argue for his preference
- early consultation in public would help both parties
- rigorous selection analysis is an important step
- best we can hope for is an *informed* judgement call

2. Problems in Decision Making

(a) Question: Is an adversarial-type public review an effective and efficient way to determine the environmental acceptability of alternative routes and sites?

Answers:
- can lead to mistrust and confrontation
- does not promote full disclosure
- government agencies often play "I gotcha"
- allows for public interventions
- promotes decision-making in public
- more likely to make proponents and government agencies accountable
- should only be used as a last resort

(b) Question: Should we de-emphasize the conventional EIS as a decision-making tool in route selection and siting?

Answers:
- it definitely needs improvement
- must specifically compare alternatives
- should clearly identify monitoring requirements
- EIS should be only one step in a process
- it could be part of a three-stage process:
    - consideration of project need
    - study of alternative routes or sites
    - assessment of selected route or site

(c) Question: Is it realistic to attempt to "analyze" public input to determine the extent to which it reflects the overall social good?

Answers:
- not analyzable in a rigorous sense
- some logical inferences can be made
- "general public" is not identifiable
- special interest groups normally prevail
- it is ultimately the responsibility of governments to decide what is the "social good"

(d) Question: What are the alternatives to ever-increasing levels of government regulation with respect to route selection and siting?

Answers:
- more early dialogue to resolve disagreements and misunderstandings
- governments should provide clear statement of requirements
- there should be some mechanism for continuous and joint project review

3. On Matters Technical

(a) Question: Is there an agreed-upon minimum level of information that must be available to properly assess routing and siting alternatives?

Answers:
- there is no generalized agreement
- a good scoping exercise would help
- replace breadth of coverage with depth of information
- data needs are site and project specific
- air photo coverage at various scales is an excellent starting point

(b) Question: Can route selection and siting criteria developed for rural and frontier areas work equally as well in urban areas?

Answers:
- in general, no
- exceptions are in geotechnical and engineering fields
- urban priority concerns include public health and safety, intensive land use competition and aesthetics

(c) Question: Is it necessary to take account of long-term climatic and geological changes in route selection and siting?

Answers:
- yes, but difficult to do
- 500+ years for geological changes
- 40-50 years for climatic changes
- important in radioactive waste disposal
- there are limited data and our predictive capabilities are poor

(d) Question: How can we improve on the timely integration of environmental, social and economic information to reduce project delays and major design charges?

Answers: - more development and use of geographical information systems

- adopt a staged process involving:
  - early project disclosure
  - early identification of key issues
  - good communication networks
  - experienced project managers
  - early public consultation

(e) Question: How should wildlife values be determined and applied to route selection and siting procedures?

Answers: - where habitat is a limiting factor, focus on potential losses

- some species are more sensitive to direct disturbances, i.e., not through habitat loss
- there are always three important perspectives: endangered species (governments), ecosystem impacts (biologists) and human values (public)
- trade-offs will depend upon dominance of roles played by above parties in particular projects

4. Conclusions

(a) We have the technical capability to route and site projects in virtually any conditions, except perhaps in the high arctic and offshore.

(b) The major problem is resolving resource trade-offs and distributing the effects in a fair manner - fair to the public and the proponent. This is primarily a political/administrative problem, not a technical or scientific problem.

(c) There is room for more cooperation between governments and proponents without unduly compromising the positions of regulatory and decision-making bodies.

(d) Decision making in any bureaucracy is a staged process from concept to implementation. EIS as presently conducted does not reflect this reality.

(e) There is a pressing need for early agreement in the EIS process on the allocation of responsibilities among all major parties involved; such an agreement needs to be clearly stated.

(f) To exclude the public is to invite disaster!

5. Recommendation

If a more cooperative approach is to be developed it must be accepted in principle at all levels in government and corporate bureaucracies. Attempts at a cooperative approach at lower levels without the support of senior management will be counterproductive and lead to confusion and frustration. Cooperation at senior levels can be interpreted as early agreement on the allocation of major responsibilities - both individually and collectively.

Therefore, it is recommended that at a very early stage in the decision-making process, senior officials from the proponent and relevant government agencies (say, at the Vice President or Assistant Deputy Minister levels) meet to set "the rules of the game." Such a meeting would:

(i) educate the decision-makers;
(ii) reveal major problem areas;
(iii) enable agreement on allocation of responsibilities;
(iv) demonstrate cooperation by example;
(v) identify individuals with responsibility/accountability;
(vi) clearly define relevant policies and regulations; and
(vii) determine how to effectively involve the public.

REGULATORY HEARING REFORM - LEGAL PRINCIPLES OF "FAIRNESS", TIMELY ACCESS TO INFORMATION and a CONSTITUTIONAL RIGHT TO FUNDING OF PUBLIC PARTICIPATION

By David Estrin, Barrister & Solicitor, Toronto, Ont.
and Edmonton, Alta., & Associate Professor, Faculty
of Environmental Studies, University of Waterloo; and
Harry Dahme, B.Sc., LL.B

ABSTRACT

A fundamental reason for encouraging public participation in decisions regarding large development projects is to allow potentially affected members of the public to understand and comment on the proposal so that, among other things, a "fair" process is achieved. Assuming that fairness is to remain a hallmark of the public hearing process, important procedural assurances must be included. Foremost amongst these are adequate notice of impending hearings, timely access to information as well as adequate funding of those who would participate in the process.

This paper examines from both a Canadian and American perspective the issues of a constitutional right to adequate funding, notice and timely access to information in the environmental and resources regulatory process.

1. Introduction

Regulatory hearings are an integral part of almost every resource development project either in the context of obtaining initial planning approval for the project or in connection with the subsequent developmental aspects, such as siting. Inherent in this generic regulatory process is the application of the concept of fairness, natural justice or "due process" of law. The dictates of these legal and constitutional doctrines may require that all persons potentially affected by the resource development project are entitled to notice of the proceedings before the regulatory tribunal. Furthermore, there is a developing practice and authority which suggest that in addition to notice, funding must be made available to allow meaningful participation in such hearings.

This paper will examine the right to notice and what constitutes adequate notice of a proposed project. It will also focus on the corollary issue of funding for intervenors in the regulatory process, the rationale for funding and, more importantly, the legal and institutional basis for funding.

2. Notice and Access to Information

The development of the concept of adequate notice is tied closely to the formulation of the nature, extent and requirements of the doctrines of natural justice and fairness. The doctrines of natural justice and fairness determine the substantive and procedural aspects of the law as it applies to regulatory agencies. Natural justice or fairness as it has been developed in the case law establishes as a bare minimum a duty on all regulatory agencies to give sufficient notice of the hearing and the scope of that hearing as will allow persons entitled to the benefit of the rule to take full advantage of their right to be heard. This is also said to involve a duty to give persons affected such knowledge of the arguments and evidence presented against their interest as will make their participation in the decision-making process meaningful.[1] What constituties adequate notice may in addition depend on the statute establishing the particular regulatory agency, or the rules developed by the agency to govern procedure before that agency. The key points are that regardless of the source of the duty to give notice, persons potentially affected by the decision-making process are entitled to (a) "sufficient" notice to (b) make their participation "meaningful".

How have these requirements been interpreted by the courts?

To a large extent the notice requirements have been determined by the nature of the proceedings and the nature of the rights affected. "Personal service on all those entitled to appear at the hearing is not an absolute requirement in every case and, indeed, where large numbers of persons are potentially affected by a decision, all that may be demanded is a public notice or advertisement in the press. There may also be differing requirements here as with other aspects of the _audi alteram partem_ rule for differing categories of persons interested in the particular proceedings. Similarly, with respect to the amount of information to be supplied in the notice, requirements vary. Where the proceedings are analogous to a criminal charge, the courts have at times demanded that the notice precisely define the statutory basis for the hearings and in addition clearly set out the possible consequences of a finding against the interest of persons affected. On other occasions, such precision is not demanded on the basis that reasonable persons would, from the amount of information supplied, have realized the nature and implications of the proceedings or at least been put on inquiry."[2]

Where the notice requirements are specified in the enabling statute, such as in the case of the Ontario Planning Act and the Expropriations Act, the courts have interpreted these provisions strictly against municipalities and expropriating authorities. [3] Where the statute provides for only "reasonable notice" and where the form and content are not specified, the rule is that the notice must be sufficiently clear, definite and particularized so as "to enable the person to whom it is directed to know what he must meet." [4]

In practical terms, what all of this suggests is that the legal requirements are more than simply notice of the time, place and character of a hearing. It is suggested that prior to a hearing it is the duty of the proponent to give sufficient notice so that a person may first determine if he is to be affected and, second, to what extent his rights may be affected. In order to be able to formulate an opinion as to the extent that his rights are to be affected, that person should then also be entitled to access to the information gathered by the proponent.[5]

For that right to access to information to be of any effect, it is only a small step to require that there be timely access to information. Information obtained on the eve of a hearing is of very little use to an individual whose rights are being determined. Notice, in order to be meaningful, requires full disclosure of the proponent's case well in advance of the hearing so that the person affected can evaluate the information received, formulate an opinion, and retain experts to verify or contradict the information received from the proponent.[6]

To the extent that the doctrine of notice developed by Canadian courts does not necessarily include requirements as to timely access and particularity, there is a line of reasoning now available as a result of the Canadian Charter of Rights and Freedoms which suggests that these requirements may have to be met in the future.

Section 7 of the Canadian Charter of Rights and Freedoms provides for the constitutional right to "life, liberty and security of the person" and the right "not to be deprived thereof except in accordance with the principles of fundamental justice." The right to "security of the person" not only refers to personal rights, but may be construed as also encompassing property rights which extend to the security of the person.[7] While s.1 of the Charter permits such reasonable limits as can be demonstrably justified in a free and democratic society, this in turn serves to underline the paramount consideration given by the Charter to individual rights as opposed to societal rights.

As a deprivation of personal rights (which may include property rights which affect security of the person) is not permitted under the Charter except in accordance with the principles of fundamental justice, the next step is to determine the scope of this right in the context of a regulatory hearing. To do this, an analogy can be drawn between the Canadian Charter and the constitutional guarantees contained in the U.S. Bill of Rights, Amendments V and XIV. These Amendments guarantee that no person shall be "deprived of life, liberty or property without due process of law." An essential element of due process is notice.

The American courts have said conclusively that notwithstanding compliance with statutory or tribunal-directed provisions for notice, notice must reach the parties affected and must convey the required information. The nature and necessity of these requirements was emphasized in Mullane v. Central Hanover Bank & Trust Co.,[8] a decision of the U.S. Supreme Court. Some quotations from that decision make these points clear.

> "The fundamental requisite of due process of law is the opportunity to be heard. This right to be heard has little reality or worth unless one is informed that the matter is pending and can choose for himself whether to appear or default, acquiesce or contest."
>
> "The notice must be of such nature as reasonably to convey the required information and it must afford a reasonable time for those interested to make their appearance." [9]

The same point was raised again before the U.S. Supreme Court in 1971 in Funtes v. Sheven [10]

> "For more than a century the central meaning of procedural due process has been clear: parties whose rights are to be affected are entitled to be heard; and in order that they may enjoy that right they must first be notified. It is equally fundamental that the right to notice and an opportunity to be heard must be granted at a meaningful time and in a meaningful manner." [11]

What these cases suggest is that notice by publication in accordance with the statutory provisions is simply not always sufficient. Notice is more than a mere gesture; the means employed must be such as can be reasonably expected to inform the affected parties. Publication as a means of notice often operates so that chance alone brings to the attention of a local resident the existence of a hearing which may affect his rights, as well as the nature of the hearing. In Mullane it was suggested that notice should name those whose attention it is supposed to attract, and that within the limits of practicability, notice should be such as is reasonably calculated to reach interested parties.[12] This was not taken to mean that personal service was necessary, but , as was pointed out, where the names and post office addresses of those affected by a proceeding are at hand, the mails would seem to be a reasonable means of giving notice.

The issue of notice was discussed again in the context of the California Environmental Quality Act by the Supreme Court of California in Horn v. County of Ventura[13]

> "...Where, as here, prior notice of a potentially adverse decision is constitutionally required, that notice must, at a minimum, be reasonably calculated to afford affected persons the realistic opportunity to protect their interest.
>
> The notice provided by the County's CEQA regulations fails to meet the foregoing standard. By limiting itself to the posting of environmental documents at central public buildings, and mailings of notice to those persons who specifically request it, the County has manifestly placed the burden of obtaining notice solely on the concerned individuals themselves. While such posting and mailing may well suffice to encourage the generalized public participation in the environmental decision-making contemplated by CEQA, they are inadequate to meet due process standards where fundamental interests are substantially affected. Those persons significantly affected by a proposed subdivision cannot reasonably be expected to place themselves on a mailing list or "haunt" county offices on the off-chance that a pending challenge to those interests will thereby be revealed. Other forms of notice appear better calculated to apprise directly affected persons of a pending decision." (pages 1140-1141)
>
> We do observe, however, that depending on (1) the magnitude of the project and (2) the degree to which a particular landowner's interest may be affected, acceptable techniques might include notice by mail to the owners of record of property situate within a designated radius of the subject property, or by the posting of notice at or near the

> project site, or both. Notice must, of course, occur sufficiently prior to a final decision to permit a "meaningful predeprivation hearing to affected landowners." (page 1141)

The court went on to say that the circulation of environmental assessment documents and the holding of various public information sessions in connection with the preparation of an application is not notice to potentially affected landowners of a subsequent adjudicative hearing that may or may not be held.

These U.S. constitutional principles appear consistent with the requirements of the Canadian Charter of Rights; both constitutions appear to impose on proponents, including proponents of resource projects, fundamental obligations as to the type of notice which must be given to persons likely affected, the manner in which it is to be given, its timing, the information the notice must contain as well as to the information that the proponent must make available to regulatory hearings.

3. Funding

Another issue, and ultimately one which may be of greater significance, is that of funding of intervenors, or citizens affected by a decision of a regulatory body. As a subject area, notice is perhaps less controversial. It is more readily defined by the existing law. But a fundamental question that arises in the context of notice is, of what value is notice, and ultimately the right to be heard, if the person affected is unable to participate in the process through lack of funding. Even if all of the procedural and substantive requirements of notice are met, the party affected may be denied the ability to participate meaningfully in the process as a result of the lack of funding. Some examples will illustrate this point.

To participate in the Canadian (federal) Environmental Assessment and Review Procedure (EARP) concerning resource development in the Canadian Arctic, the Beaufort Sea Alliance, comprising native and public interest groups, estimated that it would spend at least $289,000 in 1983-84. The

Consumers' Association of Canada spent approximately $56,000 to oppose the 1982 Bell Canada rate increase before the Canadian Radio - Television and Telecommunications Commission hearings. The Inuit Tapirisat (Eskimo Brotherhood) spent approximately $350,000 participating in the Arctic Pilot Project hearings before the National Energy Board.[14] These figures illustrate the enormous cost of participation in the hearing process and how participation can frequently be determined by the availability of funding. The result is often that the average person or group is entirely unable to participate in the process. However, a similar rationale to that employed to argue in favour of expanding notice, can also be applied to the matter of funding.

The purpose and goals of notice are to entitle persons who are likely to be affected by a decision the right to take advantage of their right to be heard and to participate meaningfully in the process. Surely this reflects an intrinsic system of values embodied in our legal system which could be used also to argue in favour of the right to adequate funding.

Aside from consistency in promoting an intrinsic set of values, there are other benefits which accrue from public participation in the decision-making process, and which would act so as to justify provision for funding.

First, it has been evident for some time that intervenors bring to the decision-making body information and perspectives not otherwise available. The value of participation on this level has been commented upon time and time again. The CRTC in the case of Challenge Communications,[15] noted that:

> "...in bringing to the attention of the Commission a tariff which was contrary to s.321 of the Railway Act and in making its case, Challenge made a substantial contribution to the effective discharge of the statutory responsibilities of the Commission...." [16]

In commenting on the Aishihik hydro-electric development in the Yukon, the Canadian Arctic Resources Committee[17] commented specifically on the effect of the absence of public participation:

> "The most noteworthy aspects of the allocation of responsibilities is that there were no actors external to NCPC [the Northern Canada Power Commission] and its consultants involved in many of the most important decisions that were made during planning and development of the project. The presence of such countervailing influences might have encouraged NCPC to investigate alternatives more thoroughly, to ensure the accuracy of cost estimates, and to schedule the implementation of the project more carefully than it did. The participation of independent organizations in these planning stages might have led to a more satisfactory outcome.
>
> Although there were no particularly strong countervailing influences affecting some of NCPC's actions, the Water Board and intervenors at the Water Board's hearings seem to have had a substantial influence on the course of the history of the project and its final outcome." [18]

Another benefit achieved as a result of participation in the hearing and the representation of all viewpoints is that the process itself is clothed with an aura of acceptability. This in turn extends to the decisions of the tribunals, which then become more publicly acceptable. Finally, it has also been said that the other benefits that accrue would be that problems of agency dependance on industry for political support would be alleviated thereby making the agency more autonomous, and that the presentation of alternative points of view would induce the decision maker to weigh the evidence more carefully and be more thorough in evaluating the evidence prior to making his decision.[19] The Law Reform Commission of Canada has acknowledged these grounds for increased public participation and, in keeping with the value accorded these benefits, has recommended that "government funding should continue to be made available for worthwhile public interest intervention activities." [20]

Having briefly dealt with the rationale for funding, the next step is to examine the legal/institutional basis for funding. There are currently four methods of funding available to intervenors in regulatory proceedings. These are the power to award costs; funding by the applicant; direct grants to intervenors; government funding. [21]

The power to award costs is a power given to the tribunal by the enabling statute. This power may be given explicitly or implicitly.

Examples of the explicit grant of the power to award costs are the Ontario Energy Board,[22] the Ontario Municipal Board,[23] and Ontario Joint Boards under the Consolidated Hearings Act, 1981.[24] Subsections 7(4)-(6) of the Act state:

> (4) A joint board may award the costs of a proceeding before the joint board.
>
> (5) A joint board that awards costs may order by whom and to whom they are to be paid.
>
> (6) A joint board that awards costs may fix the amount of the costs or direct that the amount be taxed, the scale according to which they are to be taxed and by whom they are to be taxed

There have also been arguments made to suggest that where a tribunal exercises the powers of a superior court of record, it has inherent jurisdiction to award costs. This line of reasoning has been advanced before the National Energy Board but as yet has been unsuccessful.[25]

Where a regulatory tribunal does have jurisdiction to order costs, it may do so in several ways. A tribunal may award costs in the traditional manner exercised by the courts. The general court rule is that costs follow the event and that a successful party will not be deprived of costs unless he or his counsel have been guilty of some misconduct. Exceptions to the award of costs to the successful party are where the issue is a new one, where a new statute is being interpreted, or if the action is a test case. In these three exceptions, the exercise of the discretion of the tribunal is the paramount feature.[26]

However, as is increasingly the case, it is recognized that the awarding of costs in the traditional method may place great hardship on an intervenor. This is especially true in the case of a resource development project where the intervenors, the persons affected, are individuals. It is in this type of situation that the presumption of economic equality of the parties fails and the potential for unfairness compels a more adequate response. It is in response to this type of situation where we find the law as to costs developing or changing most rapidly.

This can best be seen by briefly listing some recent court decisions and decisions by regulatory tribunals with respect to costs.

In a decision refusing the application by a ratepayers' group for judicial review of a ruling by the Ontario Environmental Assessment Board, the Ontario Supreme Court refused to award costs against the ratepayers' association. The basis for this decision was that the association had acted "responsibly" and "in good faith", and that "the matter [was] one of public importance."[27] Similarly, the Ontario Supreme Court in Re Rosenberg and The Grand River Conservation Authority [28] refused to award costs against the citizens in the area because they performed a public service in bringing the application thereby causing consideration to be given to environmental factors which otherwise would have been completely ignored.

The courts are, however, not always so kind. This can readily be seen by the recent case of Palmer v. Nova Scotia Forest Industries.[29] In this case a group of residents applied for an injunction restraining the defendant company from spraying a herbicide. The application was refused on all of the grounds advanced and costs were awarded against the plaintiffs. The legal fees were enormous and the award of costs spelled potential disaster to the plaintiff applicants.

To the extent that the courts have abrogated the traditional rules with respect to costs, administrative agencies have been quick to adopt a similar approach. The Ontario Municipal Board enunciated a policy similar to that adopted by the courts in public interest matters and has refused to order costs where the resident ratepayers lost the application but the objections had merit and were not frivolous.[30] This, of course, did little to compensate the intervenors with respect to their costs. However, where the ratepayer group has been successful, the OMB has been quick to recognize that "an administrative tribunal, exercising a specific statutory authority is not bound by the principles of the common law on costs." The Board then proceeded to award full costs to the ratepayers, to be paid by the City of Barrie, which although represented at the hearing, was not even party to the hearing.[31]

This approach was also taken by the Ontario Energy Board in the Reference Re Principles of Power Costing and Rate Making for Use by Ontario Hydro. In that case, the Board stated that it felt that "it is important to encourage active, informed and useful participation so that a wide range of views can be examined in detail. Without such interventions the burden upon the Board in a hearing could be overwhelming." The Board then proceeded to award costs to those intervenors "who have actively participated and have put forward intelligent, well-informed and effective interventions."[32]

In effect, the intervenors were funded by the applicants ex post facto.

This generosity has not yet however been extended by all tribunals to the awarding of costs prior to the hearing of an application. The Joint Board in Re Ontario Hydro - Southwestern Ontario Transmission System Expansion Program[33] in ruling upon such preliminary motion indicated it was appropriate for intervenors to attempt to raise money for costs on their own initiative, either by fund-raising or obtaining intervenor funding from the government. Interestingly enough, the Board awarded costs to the intervenors after the hearing after noting their contribution and commitment:

> "The Joint Board has taken the approach that the award of costs is to provide full public participation in public hearings of this nature and to enable the participants to bring the kind of evidence and submissions before the Board in order for it to better understand the issues raised." 34

In Alberta the Energy Resources Conservation Board Act clearly provides for costs to be paid by proponents to "local interveners." 35 Costs include both legal fees and expert witness expenses. The allocation of such costs is for the Board. Costs in advance are provided for and are sometimes given.

One of the few cases where the applicant has voluntarily agreed to fund intervenors involves the Ontario Waste Management Corporation ("OWMC"). The OWMC announced in 1982 that it would distribute funds to intervenors in future hearings in accordance with certain criteria established by the panel established to hold public hearings as to the OWMC's proposed hazardous waste facility.[36]

A third type of funding is direct grants to intervenors by the tribunal, commission or inquiry. This practice was instituted by Mr. Justice Berger in the Mackenzie Valley Pipeline Inquiry and was also adopted by the Lysyk Inquiry into the Alaska Highway Pipeline, the Thompson Inquiry into West Coast Oil Ports, the Ontario Royal Commission on the Northern Environment and the Beaufort Sea Environmental Assessment. The rationale employed to justify this source of funding is in keeping with what has already been said about the benefits to be obtained by public participation, ensuring that the evidence is as complete as possible without necessarily being biased in favour of the proponent and that the tribunal thus obtains first-hand knowledge of the concerns of the public.

The criteria for funding vary depending on the inquiry but the criteria established by the Berger Inquiry provide a good set of guidelines. These criteria are:

(1) There had to be a clearly ascertainable interest that ought to be represented at the inquiry.

(2) It should be clear that separate and adequate representation of that interest will make a necessary and substantial contribution to the inquiry.

(3) Those seeking funds should have an established record of concern for and should have demonstrated their own commitment to the interests they seek to represent.

(4) It should be shown that those seeking funds do not have sufficient financial resources to enable them to adequately represent the interests and will require funds to do so.

(5) Those seeking funds should have a clear proposal as to the use they intend to make of the funds and should be sufficiently well organized to account for the funds.[37]

The last source of funding is government programs. This generally is only available to specified groups for specific issues. An example is the funding by the Department of Indian Affairs and Northern Development of the Inuit Tapirisat in the Arctic Pilot Project Hearings.

From this brief examination it can be seen that funding is primarily available as a result of specific legislative enactments coupled with an exercise of the discretion of the tribunals to award costs.

Recently there has been discussion as to whether or not there may be a new argument in favour of funding based on the Canadian Charter of Rights and Freedoms. The argument would be based on s.7 and would flow along the same lines as the arguments advanced on behalf of expanded notice. However, where the arguments on behalf of notice succeeded, or had grounds upon which to succeed based on American jurisprudence, arguments in favour of the constitutional right to funding have no support in American case law.

The "American rule" with respect to costs is that each party is expected to bear its own costs and in the absence of statutory enactment there is no right to indemnification for costs for a successful party or an intervenor representing the public interest. That this is the rule was made quite clear by the U.S. Supreme Court in Alyeska Pipelines Service Co. v. Wilderness Society.[38] The same point was made in Turner v. Federal Communications Commission.[39] wherein the court stated:

> "Congress, and not the Commission, can authorize an exception to the 'American Rule' that litigants bear the expense of their litigation." [40]

This is the case even where the court is prepared to acknowledge the value of the participation of the intervenors. [41]

Put briefly, the constitutional right to due process in the United States does not entitle an intervenor in a regulatory or court hearing to costs. Canadian courts, however, have not ruled on the matter.

However, in 1985, s.15 of the Charter of Rights becomes effective. This provides for equality before and under law and equal protection and benefit of law. A constitutional right to have a truly fair regulatory process may be implicit. Yet until Canadian courts rule affirmatively on this issue, the right to funding for opponents of resource development projects remains one largely defined by statute. Unless there is statutory provision to award costs, an intervenor must seek direct grants from the tribunal, from the government or from the proponent. If there is however statutory authority to award costs, it is well to heed the words of the Joint Board quoted earlier, that a tribunal will not be bound by the traditional rules as to costs and that even if the resource development project is approved, the proponent may well find itself in the position of paying the costs of the intervenors.

NOTES

1. D. J. Mullan. "Administrative Law" (2nd ed.), pp. 3-113

2. Ibid, pp. 3-114

3. Metcalfe Realty Co. Ltd. v. Ottawa-Carleton (1975), 7 L.C.R. 48 (Div. Ct.)

   Re Jurgenson and City of Hamilton [1968] 2 O.R. 659 (C.A.)

   Re Jakovljevic et al v. Town of Oakville (1974) 7 L.C.R. 380 (Div. Ct.)

   Costello et al v. City of Calgary (1983) 143 D.L.R. (3d) 385, (S.C.C.)

   Wiswell et al v. Metropolitan Corporation of Greater Winnipeg (1965) 51 D.L.R. (2d), 754 (S.C.C.)

4. Reid and David, Administrative Law and Procedure (2d), pp. 65-66

   Wilson et al v. Secretary of State for the Environment et al [1973] 1 W.L.R. 1083, per Browne, J. at 1092

5. Denton v. Auckland City [1969] N.Z.L.R. 256

   Evaskow v. International Brotherhood of Boilermakers (1969) 9 D.L.R. (3d) 715 (Man. C.A.)

6. This position corresponds to that advocated by the Law Reform Commission of Canada, Independent Administrative Agencies, Working Paper 25 (1982) pp. 101-103

7. The Queen v. Fisherman's Wharf Ltd. (1982) 135 D.L.R. (3d) 307 at 315-316 (N.B.Q.B) affmd in the result, 144 D.L.R. (3d) 21

   Melvin v. The Queen (1982) 1 C.R.R. 307 at 315 (N.B.Q.B.)

8. (1950) 70 S.Ct. 652

9. Ibid, pp. 656-657

10. (1971) 407 U.S. 67 (U.S. Supt. Ct.)

11. Ibid, p. 80 [emphasis added]

12. Supra, note 8, pp. 659-660

13. (1979) 596, P. 2d, 1134 (Sup. Ct. of Calif.)

14. Ian A. Blue "The Allocation of Costs of Participation: Costs and Intervenor Funding - The National Energy Board" (1983)

15. Challenge Communications v. Bell Canada, CRTC Telecom Decision 77-16

16. Ibid, p. 39

17. W. G. Nicholls, "*Aishihik: The Politics of Hydro Planning in the Yukon*" (1981), Canadian Arctic Resources Committee

18. Ibid, pp. 89-90

19. R. Anand, I. G. Scott "Financing Public Participation in Environmental Decision Making" (1982) 60 Can. Bar Review 81

20. Supra, note 6, p. 106

21. Supra, note 14

22. The Ontario Energy Board Act, R.S.O. 1980, c. 332, s.28

23. The Ontario Municipal Board Act, R.S.O. 1980, c. 347, s. 41(2)

24. S.O. 1981, c.20

25. The argument was advanced by counsel for the Inuit Tapirisat in the Arctic Pilot Project hearings but was rejected.

26. Opcit, note 19

27. *Re Nanticoke Ratepayers' Association and Environmental Assessment Board* (1973) 19 O.R. (2d) 7, at pp. 17-18

28. (1976) 9 O.R. (2d) 771

29. (1983) 60 N.S.R. (2d) 271

30. *Re Central Wellington Planning Area Official Plan Amendment* (1978) 8 O.M.B.R. 263 at p. 284

31. *Re Township of Innisfil Restricted Area By-law 78-80* (No. 2) (1981) 11 C.E.L.R. 49

32. (1977) 6 C.E.L.N. 171

33. (1982) 11 C.E.L.R. 53

34. *Re Ontario Hydro-Southwestern Ontario Transmission System Expansion Program* (1982) 12 C.E.L.R. 62 at p.63

35. R.S.A. 1980, c. E-11, s.31. See also Interveners' Costs Regulation, Alta. Reg. 435/78

36. OWMC Regional Meeting, Chatam, Ont. Sept. 29, 1982: Statement by the OWMC Chairman. See also S.O. 1981, c.21, s.16.

37. Berger, Report of the Mackenzie Valley Pipeline Inquiry (1977) Vol. 2 pp. 225-226.

38. (1975) 95 S.St. 1612, 421 U.S. 240

39. (1975) 514 F. (2d) 1354

40. Ibid, p. 1356

41. Green County Planning Board v. Federal Power Commission (1976) 559 F. (2d) 1227, cert. denied 98 S. Ct. 1280

THE MATRICES OF POWER: REBALANCING THE PROPOSERS AND THE PUBLIC

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ABSTRACT

Those who propose energy projects possess power in the form of knowledge, purpose, group support, and, in some cases, legal rights as well. The citizen possesses fewer advantages, and so feels less powerful. His consequent anxiety or anger leads him to seek reinforcement or to frustrate the goal. The proposers--whether government agency or private utility--can do much to redress this inequity. In fostering a balance, they will enhance present communications and provide a solid foundation for public involvement in future projects within their service area.

INTRODUCTION

Utilities and power agencies seek through their proposals to provide power (energy) to small and large groups of people so that they may run their machines and their lives in greater security and with greater efficiency and pleasure. The provision of power, like everything else, is more difficult than that simple definition would suggest. The benefits of having energy readily available are not obtained without a certain price: energy facilities cost money, take up space, and often are not readily compatible with the landscapes they occupy.

To provide power with maximum efficiency and yet with a minimum of these costs is a difficult and contradictory task. It is further complicated by the need and commitment to involve and communicate effectively with those whom the facilities would affect. This brings us to a second kind of power: the complex matrix of relative powers held by each side of any communication.

Communication works best among peers. Between those of equivalent training and experience, the exchange of information is most straightforward, and the potential for misunderstanding is diminished. Fear of the other is minimized. Opportunities to subvert the communication are less often seized.

Communications between unequals may also succeed, where the relationship is benign and where the role of each participant is both clearly defined and willingly accepted by each. Teaching, for instance, proceeds best with the mutual agreement that the teacher, who possesses more authority by position, knowledge, and perhaps age, regards benignly the student who, with less power, less knowledge, and less wisdom, occupies an "inferior" position. The relationship is unequal, but parallels the superior/inferior relationship of parent and child.

Unequal situations less readily identified as benign, however, make communication more difficult. The person occupying the lesser position in power, knowledge, and/or wisdom may be uneasy. He may see himself as being at a disadvantage. Consequently, he or she may take steps to rise to peer status, to participate as an equal, or to gain the advantage in the exchange. Where this is not possible, he may seek to develop a bargaining or a threatening position or, worse, work to subvert the communication and the goal.

This sequence of feelings and actions by proposers and the public is a familiar one to utilities and power agencies. However, an understanding of the forces at work in a communication between those who propose energy projects and those who may be affected by them may enable the proposers to ask the right questions of themselves and of the public. The proposers may also then aim to establish a balance of powers that will increase the efficiency of a project, reduce the potential for misunderstanding, and enable both "sides" to feel that a fair exchange and fair treatment have played successful parts in a project.

The following discussion maps out the strategies and sources of power in communication, and suggests effective and worthwhile ways to redress an imbalance which works against successful communication and resolution when the proposers encounter the public.

COMMUNICATION STRATEGIES AND CONSEQUENCES

Language makes up for our inability to read minds:

"Just what is this line going to look like when it comes over into our valley?" 1/

With a common agreement as to what each word means, we "decode" it to follow an argument, to arrive at a point, to understand a question and prepare a response.

Language is imperfect, however. One word may mean several different things:

"You said 'closer to.' What does that mean? How much closer?"

We must see the word in context: how it appears in each sentence, who is saying it, what information and motivation the speaker possesses, and what his or her feelings are. For this reason, communication is difficult and imperfect, subject to accidental or intentional misunderstanding and to misinterpretation. This powerful tool is subject to abuse. It is equally capable of clearing the way for a positive working relationship.

1/ These and other "public comments" are representative, not actual, quotes.

Sources of Power in Communication

A primary source of power in communication is control of information. The more control one has over information, the greater the power. Consider, for instance, the following opportunities for control in any exchange:

- Release of information: Either party may choose to make some or all facts available; but what does all mean? Does available mean simply leaving the facts in a convenient place for discovery, or can it mean actively seeking out the other party?

- Timing of information: Information received too late leaves the receiver feeling abused or deceived; information received too early may be discarded without recognition of its significance.

- Sharing of information: The two "sides" or parties to a communication may exchange information; but how much and of what quality?

- Decision to receive information: Either party may choose to proceed without widening the information base to include the contributions of the other.

- Decision on what information to receive, to refuse, to ignore: Either party may decide to receive some but not all information as valid, may receive information from one source but not another, may set limits on the extent of information or on its relevance.

- Decision to interpret information: Either party may receive information from a limited or particularized point of view.

- Decision to categorize information: Either party may decide to organize the information according to pre-set categories, or according to categories derived from the total sum of information received.

- Decision to spotlight information: Either party may decide to "highlight" or give greater value to some information received, based on such values as knowledgeability or importance of the source, trust in the source, frequency with which the information appears in a set of surveys, compatibility with the party's objectives, or other criteria.

- Decision to downgrade the validity of the information: Conversely, either party may diminish or devalue information, based on reliability of the source, infrequency of appearance, or lack of compatibility with its ideas or goals.

These powers may individually be held by either or both parties in an exchange. These powers may also be abused by either or both parties. Regardless of the speaker's primary purpose in communicating, however, secondary decisions or purposes usually involve maintaining enough control of the communication (and therefore of the relationship) to enable the speaker's goal to be reached. Where goals differ, communications most often break down.

Consequences of Ignorance

Suppose, moreover, that the knowledge and training of one party exceeds that of the other, and that they address each other not as peers, but as a superior and an inferior in knowledge. The complexity increases, and the balance of power shifts.

The master/pupil relationship, while unequal, is positive within the learning environment. The assumed object of each participant is to increase the knowledge of one of them so that he or she, in turn, can independently understand and use the knowledge. In other words, the student learns enough information to be able to ask intelligent questions about the subject and to detect gaps of knowledge without the aid of the teacher.

This unequal but benevolent and protected exchange is defined by the common goals of the participants. However, when the extent of necessary knowledge is unequal and the goals of communications differ, the balance of powers is disturbed. Communication is hampered. The right questions cannot be asked until it is too late. If the less informed or disadvantaged person is unable to acquire sufficient knowledge and is therefore unable to participate in the exchange of information as an equal, he or she may become more fearful or anxious. These feelings may produce embarrassment, resentment, anger, despair, hostility--a guarantee for misunderstanding and a likely failure of communication. The exchange degenerates to a situation in which one party must "win" and the other "lose."

FACILITY SITING: COMMUNICATIONS BETWEEN THE PROPOSERS AND THE PUBLIC

Both conditions--inequality of knowledge and differing goals--often apply in communications between the proposers of an energy project and the public, those whom it would affect.

Differing Goals

First, the goals of each group frequently differ. The proposer's primary focus is to provide energy for the use of a small or large group of people, often through new construction (and energization). Subsidiary goals may be to achieve this purpose economically, without controversy, and in a timely and efficient manner. The proposers also want to achieve their goal within the legal framework specified for them and, finally, to achieve the goal with maximum benefit to the involved parties--however they may be defined.

The goals of those affected by the energy facility will vary more widely, depending on whether they perceive a direct benefit from its construction. Photographs attest to the fact that, years ago, construction crews were greeted with open arms and actual assistance in first bringing electricity to rural areas. Even today, if the affected public perceives tangible and desired benefits in the building of a facility (such as initial or needed extra energy; employment; financial or other benefits; or an increased capacity to compete in the world), their approach to the proposer's goal may be positive, and their attitudes receptive. The goals are mutually reinforcing.

But where they see no tangible or desired benefits for themselves, or benefits only to others, the reaction changes:

> "It seems to me that our community has been chosen as a national sacrifice area for the good of those energy-wasting folks back in the big cities."

If the public perceives only negative outcomes such as noise and dust, potential intrusions on their property, increased burdens on the community, and esthetic drawbacks, other goals emerge for any communication. These goals may be to preserve an established lifestyle which the facility might change; to maintain individual control in a world where the ability to do so is increasingly limited; to resist change. If these goals prove to be impossible, "lesser" goals may be added or substituted: to profit from any changes, or to be adequately compensated for these changes.

Differing Sources of Power

Differing goals alone will not necessarily unbalance any exchange of information. Where the sources of authority differ in both kind and degree, however, the chances for successful communication and resolution plummet.

The Public's Innate Powers. The public possesses firsthand information which may benefit the proposers and even shorten the planning process:

> "I've watched those eagles circle for eighteen years now, and I know building through that patch of trees is going to scare them off."

As an individual, the landowner possesses certain information the proposers may not: unstable soil conditions caused by flooding, or the yearly elk calving on a nearby mountain. Multiply his number by the count of the private parcels of land crossed, and it becomes evident that the public does possess valuable information: the local detail of natural and social life which the proposers need to enter into their estimates of the level and kind of impacts and the best location for the facility.

The public also possesses some innate resources and powers that limit the proposer's jurisdiction. They may see the utility as a service provider, with certain obligations to the public. An interaction between the public and a government power agency should theoretically reflect the principle that the government serves the people. This fact is often pointed out indignantly by those objecting to an agency proposal:

> "The government is to serve the people, isn't it? Well, we're the people, and we say put it somewhere else."

The people of a particular region may argue that the proposers should respond to the wishes of this group of citizens: put it where they suggest, not build it at all if they see no need for it, and so on. Are they not undeniably "the people," and should government not reflect their wishes?

The Proposer's Innate Powers. However, the proposers--private utility or public agency--more easily occupy a superior position by virtue of their collective knowledge and authority. The proposers are "bigger" than individual landowners in a given region. Proposers generally have experts who know more about the consequences and potential effects of their actions. And proposers have more clout: that is, more resources available to present a case and to maintain control of the relationship as well.

Despite the philosophic idea that government exists to serve the people, this notion is limited. A government represents the people as a nation before it serves the people of a particular region. The United States' Federal right of eminent domain assigns the proposing agency some other legal rights as well: if a landowner will not willingly sell his or her property or the easement rights to it, it may be condemned and taken for a "just compensation" determined by the courts. Private proposers have no right of eminent domain, but neither are they identified so strongly with public service. And they, like the governmental agency, may call to their aid the enormous resources of education and research not readily available to the individual citizen to provide power to their arguments.

Consequences of the Disparity

This inequality provides the conditions for a host of psychological consequences--anxiety, fear, and then anger--which further interfere with communication:

> "You think you can come in here with your numbers and your charts

and bamboozle us! Well, we're not just country hicks in this town, and we know what's right. You don't frighten us! And you'll be sorry you ever thought of coming through here!"

The farmer mentioned earlier may fear, for instance, the potential for unseen and therefore more frightening electrical or biological effects of a facility--a fear often compounded of rumor and misinformation, but very real to him nonetheless. He may perceive his or his family's health threatened; he may fear that buyers of his livestock may hesitate. He may fear the potential for "weed highways" which may infest his crops, or casual intrusions by the proposers on his land. He may fear that he will not be strong enough to get the proposer to agree on where to put the line. He may fear the anger of his neighbors if he agrees to a location that will affect them; or he may fear their scorn if he settles for too little compensation. He may fear that he will appear ignorant or stupid, because he does not have enough information to be able to ask the right questions, or to know when he's gotten an accurate answer. And fear is a breeder of anger. Seeing himself as more vulnerable and less powerful, the individual landowner may therefore be more suspicious, more resistant, and more angry. The prospects for effective communication diminish.

The Search for Reinforcement

The public, then, defined from the beginning of this exchange as the lesser partner in knowledge and resources, may look for reinforcement. In seeking other authorities to extend their powers and make them more "equal" to the proposers, they look for moral support, for leaders or champions, and for knowledge.

A variety of options is open to them. They may seek as individuals to invest time (and therefore money) into research: reading, asking questions, sending for information, and so on. But "spare time" is seldom enough, and few can afford the luxury of stopping work to take on a new and time-consuming project.

They may seek to increase their power through numbers, joining with other neighbors, increasing the pool of knowledge, dividing the tasks of research, and increasing the potential for discovering effective speakers or representatives. They may also choose to join with established interest groups at a national or regional level, groups with an ecological or environmental bent, groups with greater power and knowledge by virtue of their broad base and their reputation for questioning the assumptions of the proposers, as well as with greater financial support.

They may also extend their connections to professional askers of questions. The media--newspapers, television, radio--may be enlisted in a cause, particularly where the chance exists for the expression of opinion as well as of fact. The media enable a modest group of landowners to increase their appeal and their information, as they reach those less directly involved, but with similar problems or sympathies. This is particularly true in smaller communities where any news is important to the media. They may even seek to extend their power by calling upon elected officials, from the local to the Federal level. Since it is in the self-interest of those elected to demonstrate responsiveness to their constituents, they may act as intervenors on behalf of the public.

Finally, they may seek out comparable resources--time and/or money--which will enable them to become equivalent to proposers in knowledge and therefore in power. But sources are few or non-existent. By seeking out a variety of means to enhance their powers, the public seeks to attain at least equivalent status with the proposers, in hopes of having their interests adequately represented in what began as an unequal encounter.

The Need for Balance

This scenario is incomplete, because it ignores the work of the proposers themselves to begin redressing this imbalance. However, if the original premise is re-examined, one may ask whether attempting to redress this imbalance is necessary or good, or whether it is even in the proposer's interests. Perhaps the best situation is where the proposers have the best chance of "winning," and where inertia or pressing matters of family or business prevent individuals from effectively augmenting their own power.

But redress is necessary. It is good. And it is efficient in the long run. First, if the disproportion of power outlined above were to be preserved, the assumption is made that one side must "win" and the other "lose." Aside from the fact that winning is no championship when one competes against an ill-equipped opponent, such competition may be seen as inappropriate in a business of service, whether public or private. It is particularly inappropriate when it may be possible instead to arrive at a situation where the parties may speak as equals and from which each emerges with agreement, a "win."

Second, the consequences of "winning" at another's expense may well foster increased resistance when the proposers try later to provide service through the same area--a situation which recurs often, as populations and expectations increase and as more power is needed. Bitter memories live the longest. Each successive "contest" will prove more difficult to "win." Each easement or property right will be more costly, in time, money, and anger. Any present expense of improved communications will more than offset the future expenses of bitterness.

Existing Measures of Balance

Both legal and voluntary efforts have begun to redress this disproportion of power between the proposers and the public. In the United States, government power agencies are legally bound to communicate with those they may affect or whose interests they may affect. The Council on Environmental Quality has specified procedures for involving and informing citizens through "scoping": finding out what concerns the agencies and citizens of any given area may have about a proposal before and during its investigation. These regulations are designed in part to redress the unequal balance of power by insisting that the proposers discover what information is important to the public and that, at the same time, they impart information to that public. Information meetings, newsletters, "hot lines," and local offices established in communities for the duration of a project have added a variety of ways to draw the public into a common circle of knowledge and understanding. Agency environmental studies are published in draft so that the public and agencies may review the findings and comment on them and on how they were derived. Procedures for counting, studying, and responding to those comments have been developed.

QUESTIONS TO CONSIDER

Successful scoping and successful public involvement, however, rest entirely upon successful communication. The model of the teacher-pupil relationship may not be the ideal for agencies or utilities and the public. However, it does offer some benefits. The proposers can educate the public; agencies and utilities can even educate themselves to establish more overtly benign relationships with those whom their facilities affect. By paying attention to the assumptions behind and the structure of their relationships, the proposers can reduce the negative reactions to their work.

The following series of questions offer considerations which the proposers ought to address in establishing a public involvement or public relations program that will foster communication freer from the struggle between unequals. These are basic questions of policy that ought to be systematically addressed by everyone in the business of transferring power.

(1) Opportunities for Control. Since the proposers have more ways to control information, they should re-examine for each project the list offered earlier, to locate opportunities to minimize disparities:

How do we release information, and how much do we release?
How can we best reach people with a variety of educations and understandings?
When is the best time to share information?
How much do we need to teach a defined public before they can appreciate the implications of what we propose?
How do we sort through the wide variety of comments to arrive at a true representation of people's concerns?

How will we "weight" one opinion against another?
How do we show ourselves to be responsive to the public?

(2) Conduits of Information. We must also consider how information flows both to and especially from the public. Any individuals acting as conduits should have a broad-based understanding not only of the principles and problems of building a facility, but also of the psychological consequences of what will always be a disparity in power. The best conduit will not necessarily be a long-time company or agency employee, for those who labor long and well in the service of a company or agency may find it increasingly difficult to remember not only what the average citizen knows but also what he doesn't know. Power agencies and companies should seek out within their ranks a natural "devil's advocate" who can understand and address these factors, or should find means to hire a power ombudsman: an individual who may act as go-between for the proposers and the public. This may require going outside the organization in order to achieve both the appearance as well as the reality of evenhandedness. This person needs training in communications and facilitation, and must be able to represent the misunderstandings of each side to the other. His or her independence is a crucial element in establishing trust from each party. The conduit becomes a translator of concern, one who can define the necessary information and procedures to convey information to a public.

(3) Training. Other agency or utility representatives with frequent and ongoing contact with the public should receive training and practice in conflict management and communication techniques, including assessment of non-verbal communications. Ability to communicate successfully and helpfully with the public should be part of their performance appraisals.

(4) Internal Communications between the Field and Office. Energy projects are often fluid, as load growth estimates, political realities, funding, and other considerations change. If these changes affect the nature of the project, a system should be established to communicate those changes from the office (where they may be made) to the field. Field changes in siting or other location work should likewise be transmitted to the home office as rapidly as possible. If a plan is developed with some "soft spots," which are likely to change in the future, the potential for change should also be specified. Having the "rug pulled out from under you" is a surefire method to stimulate suspicion.

(5) Scoping. The seeking out of public concerns, whether in a general sense before the project is firmly developed, or later, when alternatives are

defined by narrower corridors or even by centerlines, should be done by persons trained in communications. Where written comments form an important part of the public involvement in a project, careful attention should be paid to the training of analysts who will be able to pick out not only the overt, but also the underlying message. Where more than one reader is involved, frequent cross-checking should be done to ensure that comments are identified in a consistent manner. This is particularly important in the context of public meetings, where speakers do not have the organization of or control over their expression available to those who write.

(6) Content of Comments. A systematic means of defining a comment is also crucial, for the definition must be broad enough to include marginal comments or comments on related topics. The comment analyst must also be able to distinguish which comments require a response, and which are expressions of feeling or "votes" on a route or plan. A good working definition might be: "A comment is an observation or an expression of opinion which possesses a clear subject and which suggests, assigns a value, makes a judgment, identifies a concern, or corrects an error."

This definition enables one not only to recognize an obvious comment ("Plan A is better than Plan B, because it affects fewer residences."), but also includes comments offered as facts ("My employees won't work under the line."), and comments offered as questions ("How many more lines are really going to come through here?"). The ostensible content of that last comment, for instance, is a mere tally of lines. The comment, however, conveys a clear message of suspicion and mistrust; the commenter is really asking "how much can I trust you?" It is important that, whenever possible, people's feelings be addressed as well as the statements which convey them. Those identifying comments, as well as those responding to them, must be trained to assess both.

(7) Delineating Public Involvement. Finally, every company or agency involved in the business of power and public involvement should establish a standard list of questions to enable them to define a public involvement plan which particularly suits the needs of each project. Such questions should include some or all of the following:

What information do we share with the public? How accurate and ambitious is that information? What is the best format for an exchange of views and information?

What do we know technically about the project?

How "hard" is the information?
What don't we know?
Are we willing to share that lack of information with our public in clear and unambiguous terms?
How can we accurately explain the fluidity of forecasts to the public?
How much do we want them to know?
What formats for exchanging information can we devise that will minimize fear and confrontation?

What do we know about the nature of the audience?

What are the priorities and values of the people in a given area?
What are their values without regard to the project?
What is their level of education or knowledge?
What is their level of sophistication?
What attitudes might be encountered?
What community support systems exist which might lend themselves to bolstering the knowledge and self-assuredness of individuals?
How can we work with those support systems?

How can we explain the way we make decisions to a community? How can we assure them that we take their views seriously?

Can we identify the decisionmakers?
Can we give a community or representative individuals within it access to such decisionmakers?
Can we assure them of the roles their opinions and information play?
Is there a means to insure that all public comment and opinion on a project reach the evaluators or decisionmakers?
Is there an adequate means to convey intensity of concern?
Is there a means to ensure that simple numbers of commenters are not overvalued by contrast with a smaller interest group with equally valid concerns?
How shall we respond to questions and comments?
How shall we respond to their feelings as well as to their questions?

And finally:

How much do they need to know?
How much do they get to know?

To meet the goals common to our utilities and agencies--to construct with efficiency and economy, in a timely and non-controversial manner, to interact positively and cooperatively with those members of the public on whom our facility will have an impact--we must be prepared to transfer power in our communications. We must make the public and the public servant (or the private provider of service) more nearly equal in information; we must formulate policy that minimizes chances for misunderstanding; and, above all, we must focus on removing the element of fear from the interchange. The complicated matrix of power must be designed for each project so as to reduce the inequalities of each interchange and make possible communication and resolution in which both parties may win.

SESSION III A - REGULATION AND ADMINISTRATION

NEW APPROVAL PROCESS IN ONTARIO - CASE STUDY OF APPLICATION FOR MAJOR ELECTRIC TRANSMISSION FACILITIES

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ABSTRACT

This case history examines Ontario Hydro's Southwestern Ontario Transmission application and the progress to date of that application through the public hearings and approval process. An overview of the Consolidated Hearings Act, 1981 is provided along with the considerations which led Ontario Hydro to adopt a two stage approval process under the new legislation.

Two successive Environmental Assessments have been submitted and the second stage of hearings is now scheduled to begin in March 1984.

Initial experience by Ontario Hydro on two major undertakings provides a basis for preliminary commentary on the operation of the new legislation.

INTRODUCTION

Ontario Hydro is a public corporation, which was created in 1906 by a law passed by the legislature of the Province of Ontario. The mandate of the Corporation is to provide electric service to the people of the province and the power, responsibilities and regulatory controls on the Corporation flow from the current form of the legislation entitled "The Power Corporation Act". In physical terms, this means we own and operate the generation and transmission facilities to supply electricity to over 330 municipal utilities who in turn service over 2,000,000 customers; and through our own distribution network to over 780,000 direct customers.

Between the end of the second World War and the early 1970's, the development and expansion of the power system kept pace with a steady 7% growth in load. However, in the early 1970's, Hydro began to experience serious delays in acquiring new facilities as the public demanded a greater say in the planning. Two special government appointed enquiries and a Royal Commission on Electric Power Planning were held over the next eleven years and in addition, two significant pieces of legislation were passed, namely The Environmental Assessment Act, 1975, and The Consolidated Hearings Act, 1981.

These events dramatically altered the approval process for major transmission projects in Ontario. This paper examines the new approval process with particular emphasis on the incorporation of The Consoldiated Hearings Act and its current application to the planning of new 500 kV transmission facilities in Southwestern Ontario.

PLANNING DIFFICULTIES DURING THE 1970's

Up to 1970, Ontario Hydro had followed time honoured methods for selecting transmission routes, consulting with government authorities, acquiring the property rights and constructing the facilities. Problems were minimal, expropriations were rare and the facilities were generally brought into service on time. It was in such a comfortable environment that we began to plan and locate an extensive 500 kV bulk power grid to overlay the existing 230 kV bulk power grid throughout the province. As the initial elements of this plan were unveiled and municipal and provincial route approvals sought, public opposition began to rise sharply. This opposition became so intense that in 1972 the provincial government appointed the Solandt Commission to enquire into the routing of the initial phase of the 500 kV network which we had hoped to have in-service by 1975.

During the Solandt Commission, Hydro became painfully aware that earlier government blessing of our system plan and routes was rather meaningless as powerful environmental and agricultural groups intervened in the planning and acquisition process. These groups claimed that Hydro's plans lacked public involvement, adequate analysis of alternatives and consideration of environmental factors.

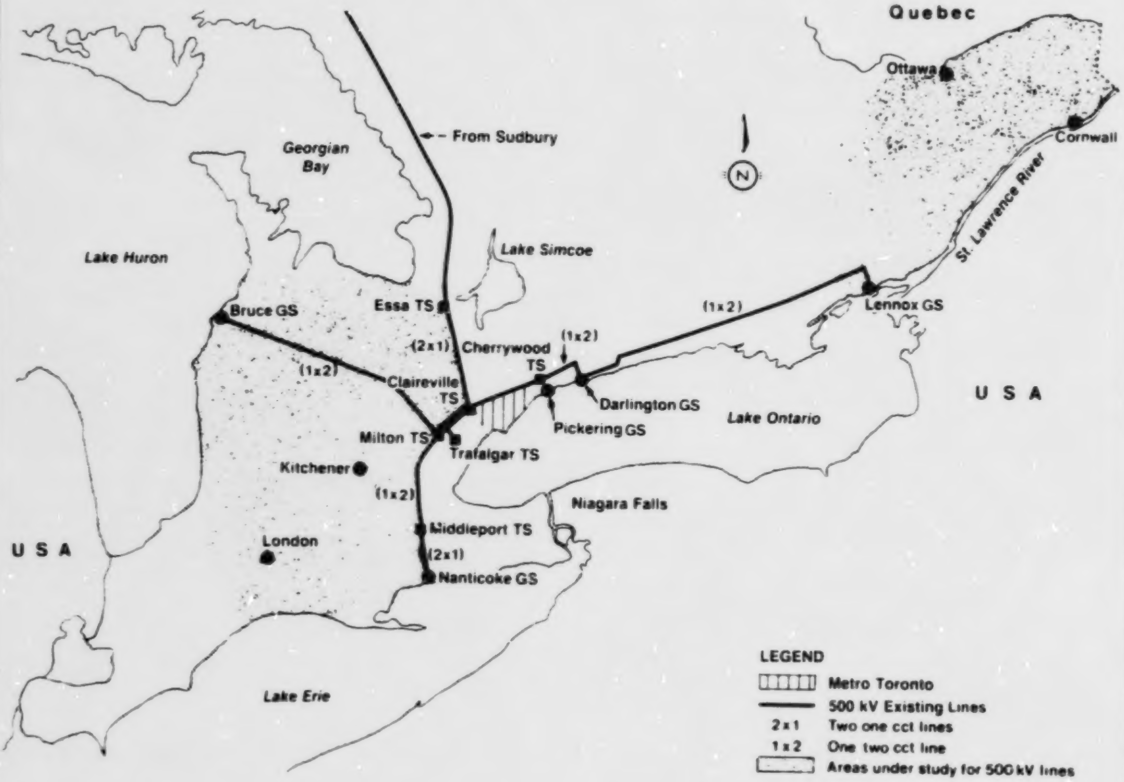
Following extensive hearings, government approvals were received and the initial major links of the grid were eventually placed in service at 500 kV as follows:

Nanticoke GS to Claireville TS - 1979
Bruce NPD to Milton TS - 1980
Lennox GS to Cherrywood TS - 1980
Claireville TS to Cherrywood TS - 1982

The 500 kV system in southern Ontario as it stands today is shown in Figure 1.

The delay of several years in placing these initial lines in service has resulted in large cost penalties. To date, the lack of adequate transmission out of the Bruce Nuclear Power Development (Bruce NPD) has cost approximately $52 million due to the need to burn coal to replace the cheaper "bottled up" nuclear generation. Significant capital costs have been incurred to install a load and generation rejection (LGR) scheme so that maximum use can be made of the nuclear units as they come on stream during the 1980's at Bruce NPD. Even with the LCR scheme in place, when the final nuclear unit comes into service (January 1987), the "bottled" generation problem will recur at an expected cost penalty of between $50 to $100 million per year until the next 500 kV line is placed in service.

In connection with the government approval, in 1974, of the Bruce NPD to Milton TS 500 kV line, they announced the appointment of the Royal Commission on Electric Power Planning (RCEPP). One of its priority tasks was to investigate and report on Ontario Hydro's claims that there was an urgent need to extend the 500 kV system into the Ottawa area and into Southwestern Ontario. This effectively halted Hydro's planning on these projects during the RCEPP hearings. In 1980, RCEPP delivered its final report and the government endorsed its findings that more transmission was indeed needed in these areas.


Quebec
Ottawa
Cornwall
St. Lawrence River
From Sudbury
Georgian Bay
N
Lake Huron
Lake Simcoe
Essa TS
Bruce GS
(2x1)
Cherrywood TS
(1x2)
(1x2)
Lennox GS
(1x2)
Claireville TS
U S A
Darlington GS
Pickering GS
Lake Ontario
Milton TS
Trafalgar TS
Kitchener
(1x2)
Niagara Falls
Middleport TS
U S A
London
(2x1)
Nanticoke GS
LEGEND
Metro Toronto
500 kV Existing Lines
2x1 Two one cct lines
1x2 One two cct line
Areas under study for 500 kV lines
Lake Erie

500kV TRANSMISSION SYSTEM
SOUTHERN ONTARIO
1984

FIGURE 1

Meanwhile, in 1976, the government passed the Environmental Assessment Act (EA Act). Although it was considered the first piece of legislation to go through in the planning and approval process, there was no assurance that matters decided under the EA Act would not be reassessed by subsequent tribunals under other Acts. This long standing weakness had, of course, evolved over the years as new Acts came into being creating new hearing requirements, and overlapping jurisdictions and terms of reference.

RCEPP identified these fundamental problems with the approval process as did Municipalities and other proponents having to face hearings under the EA Act in addition to other Acts.

The government response was the passage of the Consolidated Hearings Act in July 1981.

The first program registered under this new Act was Ontario Hydro's Eastern Ontario Transmission Program followed closely by the Southwestern Ontario Transmission Program.

CONSOLIDATED HEARINGS ACT - 1981

The primary purpose of the Consolidated Hearings Act is to provide a streamlined approval process for municipal, private and provincial projects and programs which require hearings by more than one tribunal under more than one Act.

Twelve specific Acts, passed over many years, which have to do with Municipal and special area planning, protection of the environment and the expropriation of property are encompassed by the Consolidated Hearings Act (C.H. Act). When a proponent chooses to place an undertaking under the C.H. Act, written notice is given to the Hearings Registrar. Members are then selected from the appropriate tribunals to form a "Joint Board". This Joint Board is then seized for the duration of that case; that is until all decisions under all relevant Acts are obtained or the undertaking is withdrawn.

The decisions of the Joint Board may be appealed to the Cabinet of the Province of Ontario.

A useful feature is the ability of the Joint Board to defer unto itself future decisions pending the submission of further submissions as planning proceeds.

Since the C.H. Act was proclaimed in July 1981, fifteen (15) applications have been made up to January 1984. Most of the applications are from Municipalities for sewer, water and roads projects as well as landfill sites. Three private undertakings were initiated but are already withdrawn or expected to be withdrawn. The two largest undertakings are the transmission programs of Ontario Hydro.

Excluding the two Ontario Hydro undertakings, the present status of the applications under the C.H. Act may be summarized as follows:

- 2 projects have been withdrawn;
- 3 projects are awaiting hearings;
- 2 projects were settled without requiring a joint board decision;
- 6 projects have received final decisions by a joint board
    - 3 approved (1 appeal pending, 1 appeal rejected by Cabinet)
    - 3 not approved (Cabinet overturned these 3 decisions but 1 is under Judicial Review at the Supreme Court level).

Costs have generally been awarded where the parties have made a significant contribution and the hearings have been lengthy. Hearings have ranged up to about 50 days.

The style of hearings conducted to date may be characterized as follows:

- Hearings are open to the public and a level of informality is set to encourage participation by the public.
- Notice provisions go beyond legislative requirements in an attempt to satisfy natural justice and practical considerations.
- Two kinds of interested persons are permitted - parties and participants. Parties, whose rights are addressed in the legislation, are expected to be involved in cross-examining witnesses while participants are less involved, although equal weight is given to their concerns.
- Witness statements are generally prepared and exchanged as well as interrogatories which are encouraged to reduce hearing duration.
- Prior to a hearing, notice of motions may be brought before the Board.
- The hearing itself follows traditional routines regarding introduction of evidence, cross-examination, and argument.
- Media may be admitted and record proceedings with prior approval.

The Joint Board has the power to summon witnesses and the witness cannot refuse to answer a question on the grounds that it may tend to incriminate or establish liability in a civil proceeding. The witness may, of course, request the protection of Section 5 of the Canada Evidence Act.

THE TWO STAGE APPROVAL PROCESS

With the passage of the C.H. Act, the legal mechanism was now available to plan and develop major projects in stages; initially addressing the broader issues and obtaining some general decisions then moving successively to more specific analysis and decisions. This more ideal match of the planning process with the legislative decision making process would hopefully lead to more orderly and timely project development and yield more predictable results, greater public acceptance and fewer surprises for the political decision makers and proponents.

It was clear from the language of the EA Act and the wholistic approach of staff of the Ministry of the Environment that broad scale issues would have to be addressed in a comprehensive manner and thoroughly documented in the Environmental Assessment. The key question was whether to take the risk of moving directly from the broad decisions to the detail route selection studies without pausing to obtain regulatory approval; or to stop and obtain such on external endorsement before committing resources to the next level of planning.

In considering the potential of the new legislation together with the status of planning on the 500 kV transmission projects, Ontario Hydro decided to place these major projects under the C.H. Act and split the planning and approval process into two successive stages.

The first stage, called the Plan Stage, would have the objective of obtaining approval for an electric power system plan. This plan would be established by deciding on the following elements:

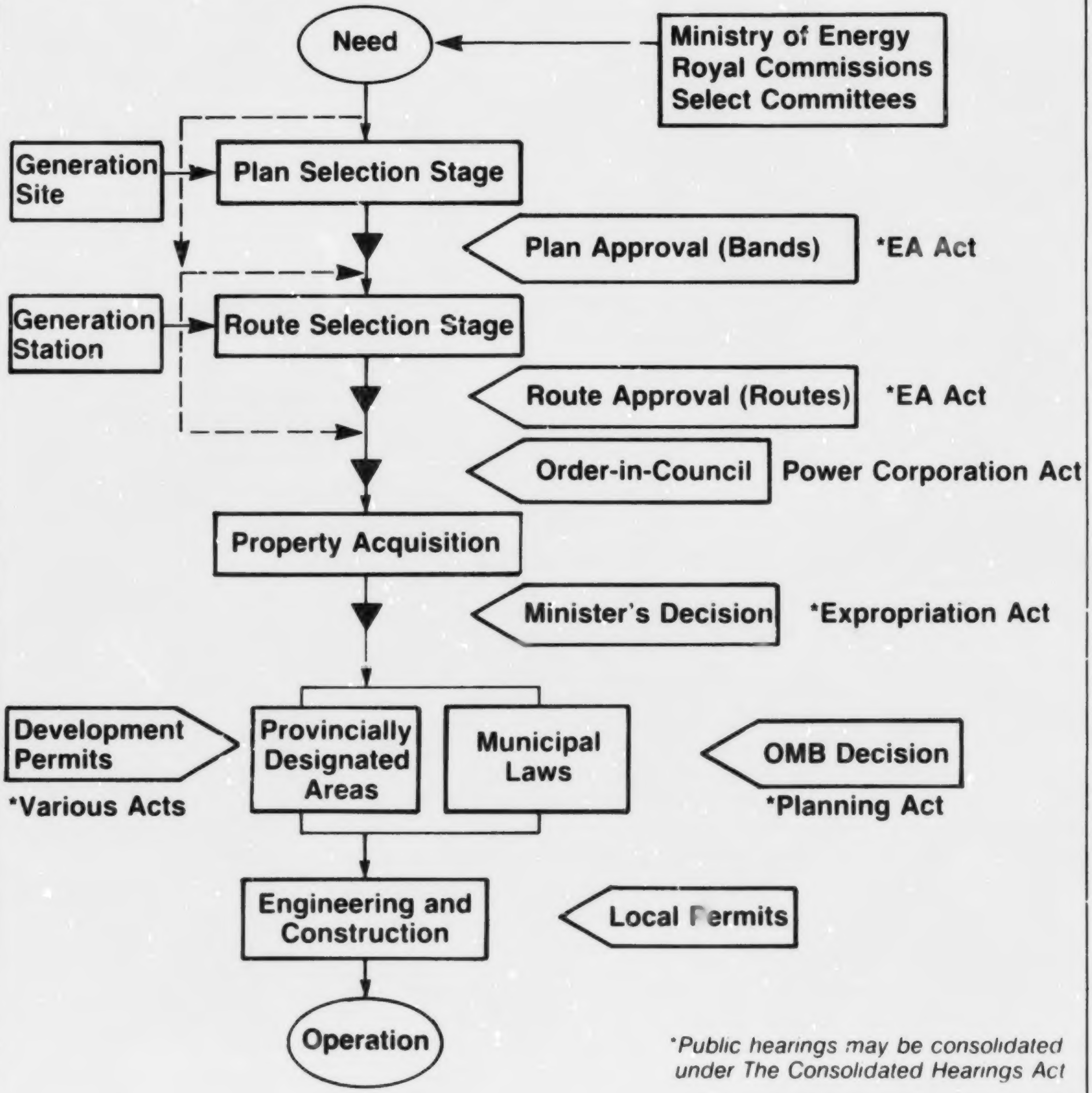
- the voltage and number of circuits of the transmission line;
- the terminal points to be connected by the transmission line;
- the general geographic area within which route selection studies would be conducted (Route Stage Study Area).

In order to reach these decisions pursuant to the EA Act, it is necessary to prepare an EA and submit it to the government for review. The matters which must be addressed and the factors considered and documented in the Plan Stage EA are discussed later in the paper.

Following Plan Stage hearings and decisions, the planning would move into the Route Stage. The objective of this stage would be to obtain an approval for the routes of the transmission lines and the sites for the transformer or switching stations. In order to reach this objective, it is necessary to prepare a second EA and submit it to the government for review.

This two stage approval process adopted by Ontario Hydro in 1981 is illustrated in Figure 2.

Some site specific and property owner matters traditionally dealt with under the Expropriations Act are not provided in the Route Stage EA. These matters cannot be fully addressed until access is gained to private property and engineering information obtained and discussions held with each property owner. Tower locations and right of way boundaries will then be determined. It has yet to be determined how the Joint Board will deal with these specific landowner locational issues. It is hoped that a formal third stage of hearings, traditionally referred to as the "enquiry" hearings, will not be necessary, but rather brief local mediation by a designate of the Joint Board could handle the expected few cases where Ontario Hydro and the landowners cannot reach agreement on location. Thus, the C.H. Act addresses the process up to, and including, the registration of the necessary property rights to construct and operate the facilities. The matter of compensation is not included in the terms of the C.H. Act, but will continue to be handled in the traditional way.


Need
Ministry of Energy
Royal Commissions
Select Committees
Generation Site
Plan Selection Stage
Plan Approval (Bands)
*EA Act
Generation Station
Route Selection Stage
Route Approval (Routes)
*EA Act
Order-in-Council
Power Corporation Act
Property Acquisition
Minister's Decision
*Expropriation Act
Development Permits
*Various Acts
Provincially Designated Areas
Municipal Laws
OMB Decision
*Planning Act
Engineering and Construction
Local Permits
Operation

*Public hearings may be consolidated under The Consolidated Hearings Act

GENERALIZED
TRANSMISSION ROUTE PLANNING AND
APPROVAL PROCESS
FIGURE 2

PLAN STAGE EA - SOUTHWESTERN ONTARIO

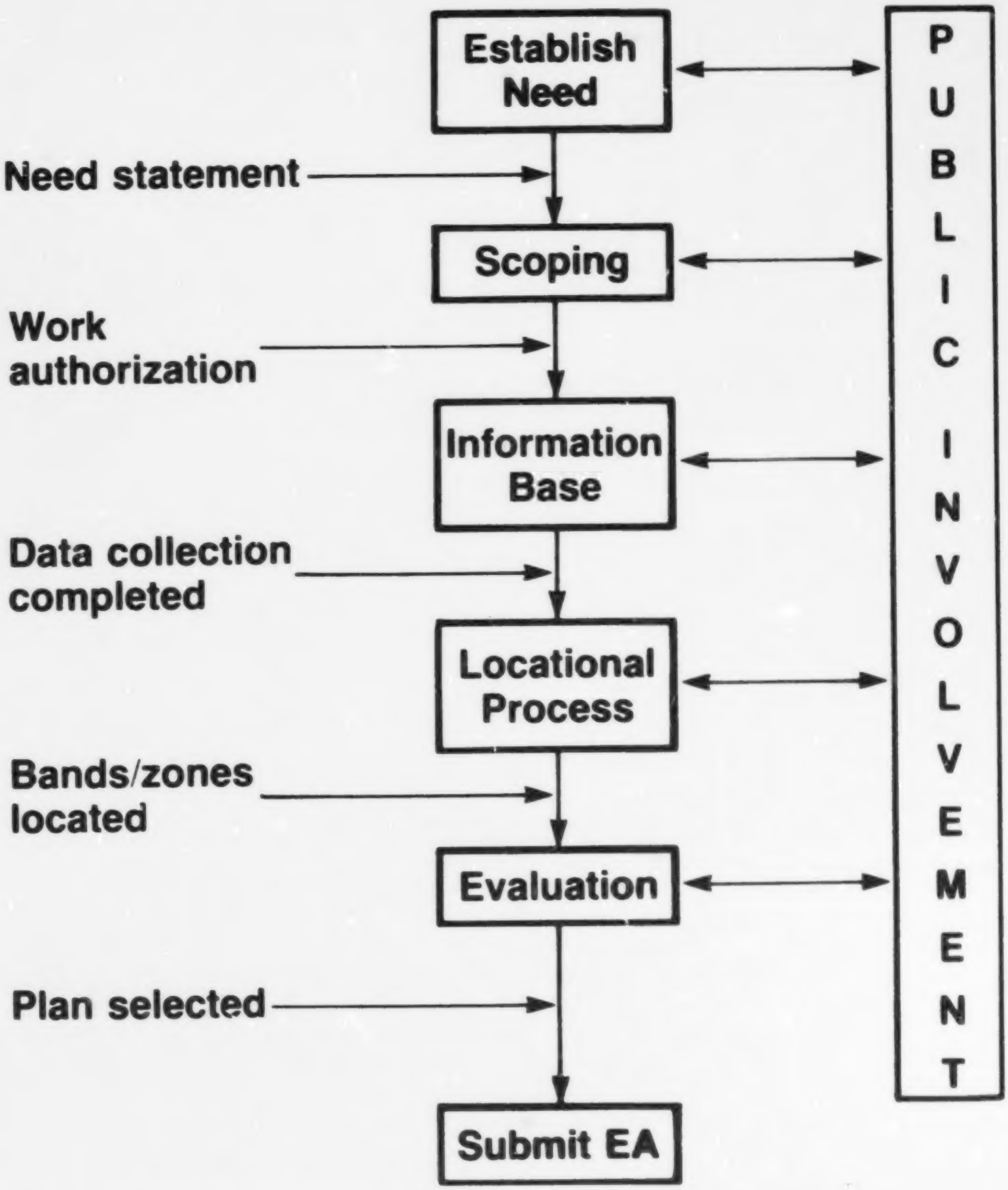
The generalized process[1] used by Ontario Hydro to carry out an environmental assessment of provincial/regional power planning schemes is shown in Figure 3.

RCEPP had dealt extensively with the subject of "need" during its hearings and concluded that additional transmission was the appropriate way to solve the forecasted power supply problems. However, Section 5(3) of the EA Act requires that "alternatives to" the undertaking be assessed as well as "alternative methods" of carrying out the undertaking. Therefore, the Plan Stage EA first addressed the broad scale alternative solutions such as wind and solar generation, co-generation, no project and traditional forms of new generation (hydraulic, fossil, nuclear) to demonstrate that new bulk transmission was preferred both economically and environmentally. Then, six alternative transmission arrangements were developed which were technically acceptable based on electric power system criteria. A geographic area was selected to encompass all the alternative terminal points and feasible routing alternatives (Figure 1).

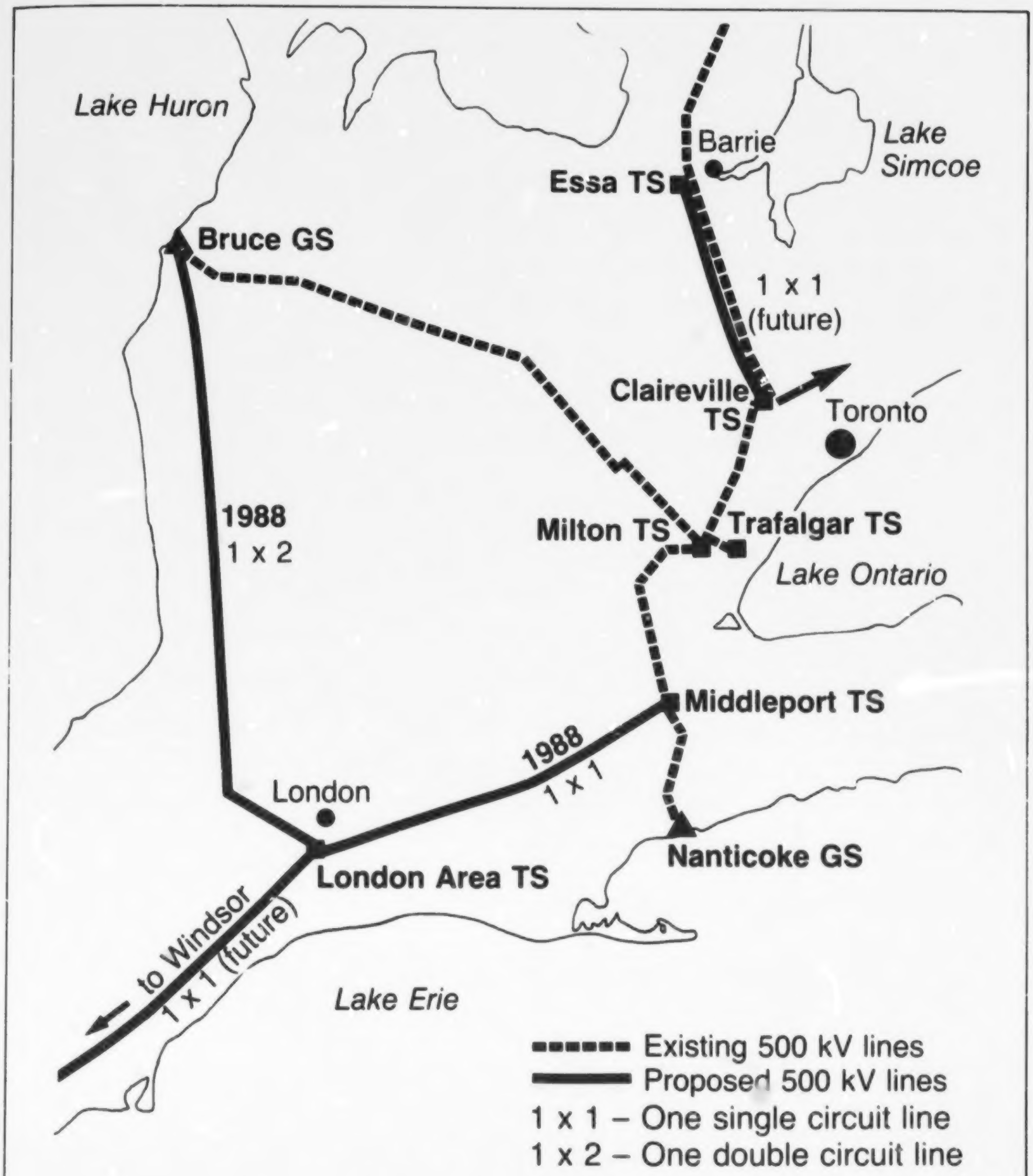
Environmental information was gathered and mapped at a scale of 1:250,000 and given a value system which was derived through a public involvement program. Alternative transmission bands were located in the low constraint areas, where possible, to meet the six alternative system arrangements. Engineering, economic and environmental comparisons were then done and Plan M1 was selected as the recommended system plan (Figure 4). These studies were documented in the Southwestern Ontario Transmission - Plan Stage EA[2] which was submitted to the government in October 1981.

The Ministry of Environment co-ordinated the comments of all government ministries and agencies and issued the EA Review[3] in December, 1981.

In the Review, all Ministries generally supported the undertaking and the EA submitted by Ontario Hydro. Many ministries felt that the general level of environmental information associated with the Plan Stage EA limited their ability to give detail comments but they planned to participate to a much greater extent in the Route Stage EA. Most of the concerns raised in the Review came from the Ministry of Environment review co-ordinator who dealt extensively with the manner in which the EA addressed the requirements of Section 5(3) of the EA Act. These concerns related mainly to the conceptual aspects of the scope and purpose of the undertaking and the extent of study devoted to alternatives to the undertaking and alternative methods of carrying out the undertaking. The Review did not make recommendations with respect to acceptance of the EA or approval of the undertaking, but deferred these matters to the Joint Board whose Plan Stage hearings were to begin shortly thereafter.


Establish Need
Need statement
Scoping
Work authorization
Information Base
Data collection completed
Locational Process
Bands/zones located
Evaluation
Plan selected
Submit EA
PUBLIC INVOLVEMENT

SYSTEM PLAN STAGE
STUDY PROCESS
FIGURE 3


Lake Huron
Barrie
Lake Simcoe
Essa TS
Bruce GS
1 x 1
(future)
Claireville
TS
Toronto
1988
1 x 2
Milton TS
Trafalgar TS
Lake Ontario
Middleport TS
1988
1 x 1
London
London Area TS
Nanticoke GS
to Windsor
1 x 1 (future)
Lake Erie
Existing 500 kV lines
Proposed 500 kV lines
1 x 1 – One single circuit line
1 x 2 – One double circuit line

RECOMMENDED PLAN M1
FIGURE 4

PLAN STAGE HEARINGS

Ontario Hydro made application to the Hearings Registrar to have the Southwestern Ontario Transmission program placed under the C.H. Act. The Joint Board formed for this case consisted of 2 members of the Ontario Municipal Board and 1 member of the Environmental Assessment Board who was appointed Chairman.

Shortly after the release of the government's EA Review, the Joint Board began the main hearings. These hearings, which lasted for 35 days and finished in April 1982 were held at one central location in the study area. Although about 10 parties and 39 participants are listed in the proceedings, only about a dozen were involved extensively at the hearings with the greatest participation coming from agricultural groups.

The style of the hearings was generally as described earlier in the section on the Consolidated Hearings Act.

Ontario Hydro used witnesses quite extensively to give the evidence-in-chief rather than resting on the EA documents and other written submissions. This was done because of the magnitude and complexity of the case and to make the investment for the subsequent stage of hearings under the same Board.

In addition to the 11 Ontario Hydro witnesses, 46 other witnesses participated in the hearings and 181 exhibits were filed.

The main issues which surfaced at the Plan Stage Hearings included the following:

- the definition of the "undertaking" in the EA, particularly as it related to the statements on the "purpose of the undertaking", "alternatives to the undertaking" and "alternative methods of carrying out the undertaking".
- the range of alternatives considered in the EA and the amount of study devoted to each before discarding them from further study.
- electric load forecasting methods and results.
- currency and scale of the agricultural data used.
- certain aspects of the environmental methodology, for example: weightings, comparison technique and scale.
- impacts on the Niagara Escarpment.

One provincial government ministry, Agriculture and Food, presented a case quite critical of Ontario Hydro's methodology even though they had not done so in the EA Review document.

In June 1982, the Joint Board issued its "Reasons for Decision" report. In summary, they found Ontario Hydro's EA to be acceptable, the range of alternatives reasonable and the medium load growth scenario valid. They placed prime importance on minimizing agriculture impact from the proposed transmission facilities. They also used the opportunity to express their views on the somewhat controversial point of the role of the environmental review co-ordinator, from the Ministry of the Environment, in carrying out a government review of a proponent's EA.

In July 1982, the Joint Board decision was issued selecting a modified Plan M3 (Figure 5) rather than the recommended Plan M1. The significant modification to Plan M3 required Ontario Hydro to study routings along Hwy. 401, a major expressway between London and Toronto, and present evidence on the matter at the next stage of hearings. This modification had been suggested by some agricultural interests at the hearings as a possible way to reduce the higher agricultural impact of Plan M3.

The Board was careful to note that its decision was "without constraint" to any decisions to be made subsequently by it in respect to any matter deferred by Order of the Board made Dec. 16, 1981 and confirmed Feb. 24, 1982. The Board's own explanation of this condition is that "the Joint Board may find it necessary to modify, alter or resolve conclusions which have been reached at an earlier phase of the hearing. The Joint Board renders a decision which takes into account the current findings and conclusions. The net result of this approach is the issuance of a decision on each phase of the hearing, and each decision is a cumulative determination of all facts and issues previously presented. The decision on the undertaking, therefore, is the final determination which is made following the last phase of the hearing".

The Route Stage Study Areas within which route selection studies were to take place are shown in Figure 6.

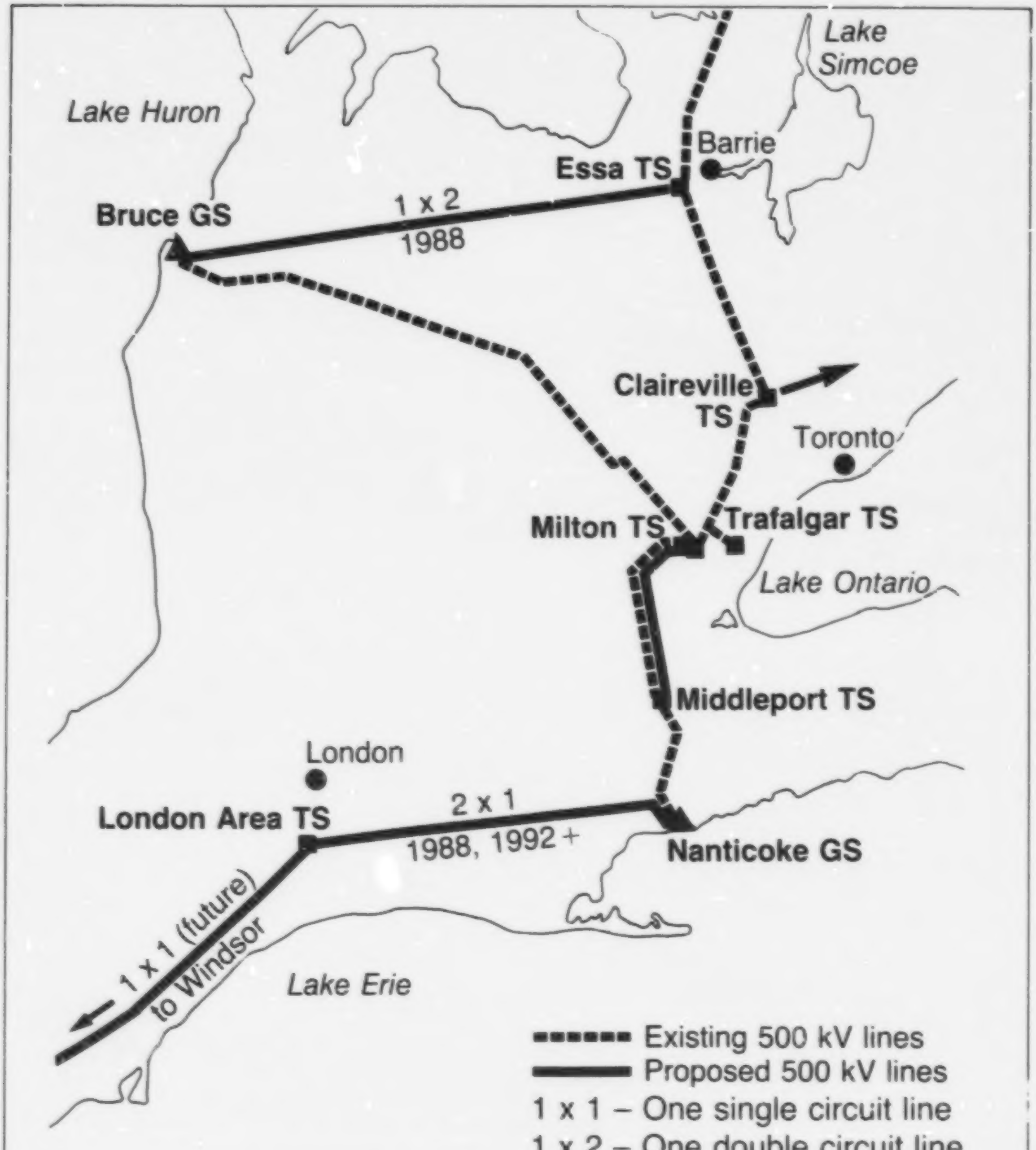
The Joint Board decision was appealed to the Cabinet by over 40 parties. The main grounds for these appeals were that the Notice of Hearings given by the Joint Board was inadequate and misleading and that the hearings were at one location only. However, in September 1982, the Cabinet rejected all the appeals and upheld the decision of the Joint Board.

ROUTE STAGE EA

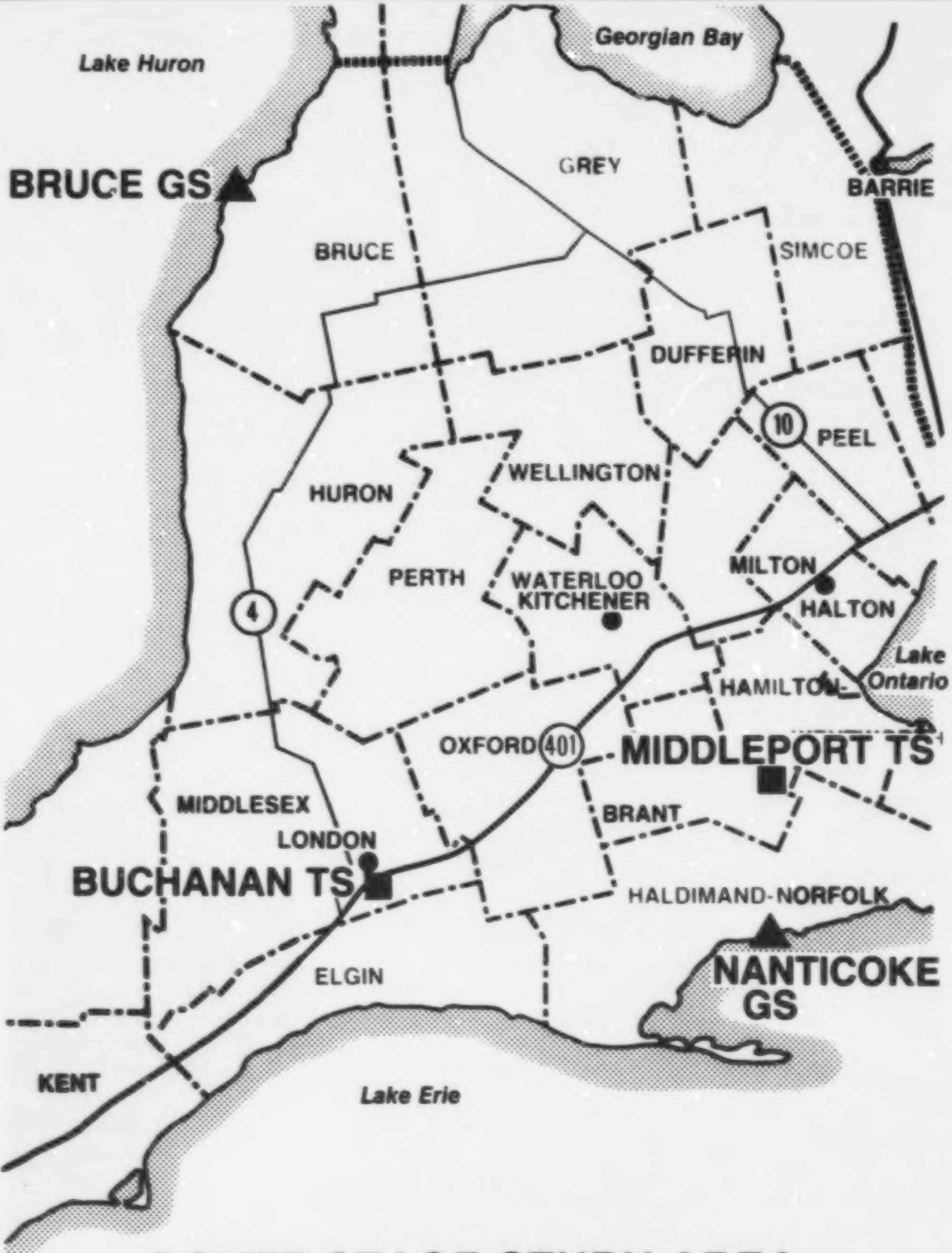
Route selection studies were conducted generally within the geographic areas, called "Route Stage Study Areas" set out in the Joint Board decision, and the study process used was conceptually similar to the Plan Stage, but applied at increasing levels of detail.

As Ontario Hydro moved out into the community to begin these studies and form public working groups to assist us, it soon became apparent that those affected negatively by the Plan Stage decision were mainly interested in questioning the Joint Board's decision and the adequacy of notification and involvement in the Plan Stage hearings. However, during the educational phase and information gathering phases from the summer of 1982 to the spring of 1983, the groups met regularly and developed a public ranking for the environmental information.

Based on the environmental constraint maps (scale 1:50.000) and economic and engineering factors, alternative corridors (1-4 km wide) and zones (1 km square) were located with the assistance of the working groups. At the same time, property make-up was mapped and a name and address search done for all alternatives. This information was used to notify over 35,000 people of public information centres where they could review the alternative corridors and zones.


Lake Huron
Lake Simcoe
Barrie
Essa TS
Bruce GS
1 x 2
1988
Claireville TS
Toronto
Milton TS
Trafalgar TS
Lake Ontario
Middleport TS
London
London Area TS
2 x 1
1988, 1992 +
Nanticoke GS
1 x 1 (future) to Windsor
Lake Erie
Existing 500 kV lines
Proposed 500 kV lines
1 x 1 – One single circuit line
1 x 2 – One double circuit line

PLAN M3
FIGURE 5


Lake Huron
Georgian Bay
BRUCE GS
GREY
BARRIE
BRUCE
SIMCOE
DUFFERIN
10
PEEL
WELLINGTON
HURON
MILTON
PERTH
WATERLOO
KITCHENER
HALTON
4
Lake Ontario
HAMILTON
OXFORD
401
MIDDLEPORT TS
MIDDLESEX
BRANT
LONDON
BUCHANAN TS
HALDIMAND-NORFOLK
NANTICOKE GS
ELGIN
KENT
Lake Erie

ROUTE STAGE STUDY AREA
MODIFIED PLAN M3
FIGURE 6

As planning progressed towards more specific locations for the transmission lines, the general public became increasingly involved and the Chairmen of the working groups began to experience difficulty in controlling meetings and maintaining schedule. Newly formed citizens' groups were attending in large numbers and disrupting their meetings. One working group disbanded while another halted work for the summer, then disbanded in the fall.

Within the corridors and zones, further more detailed data was gathered and mapped at a scale of 1:15,000. Alternative transmission routes and station sites were then identified. Engineering, economic and environmental evaluations were then conducted leading to the selection of the recommended routes and station site (Figure 7) which was announced in November 1983.

In the north part of the study, a 158 km route was selected for the 500 kV 2 circuit transmission line from the Bruce Nuclear Power Development on Lake Huron to the Essa Transformer Station near Barrie, Ontario.

In the south part of the study, a 113 km route was selected for the first 500 kV single circuit transmission line generally parallel to Hwy. 401, a major expressway from London to Toronto. A route was also selected (122 km) for the second 500 kV single circuit line generally utilizing existing rights of way from London to the coal fired Nanticoke generating station on Lake Erie. These two new routes terminated at the proposed site of a new Transformer and Switching station in the London area. The plan also includes twinning an existing 500 kV line from the Nanticoke area to Toronto (65 km).

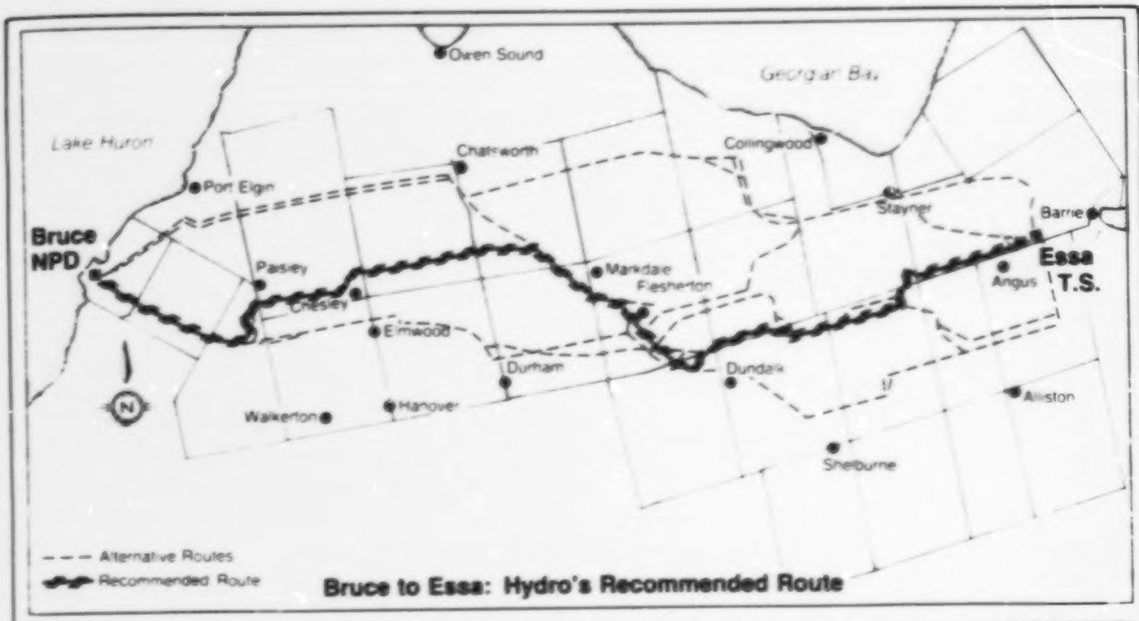
The EA documents for the Southwestern Ontario Transmission - Route Stage were completed and delivered to the government on December 1, 1983[5].

The government review of the EA was issued by the Minister of the Environment on February 3, 1984[6].

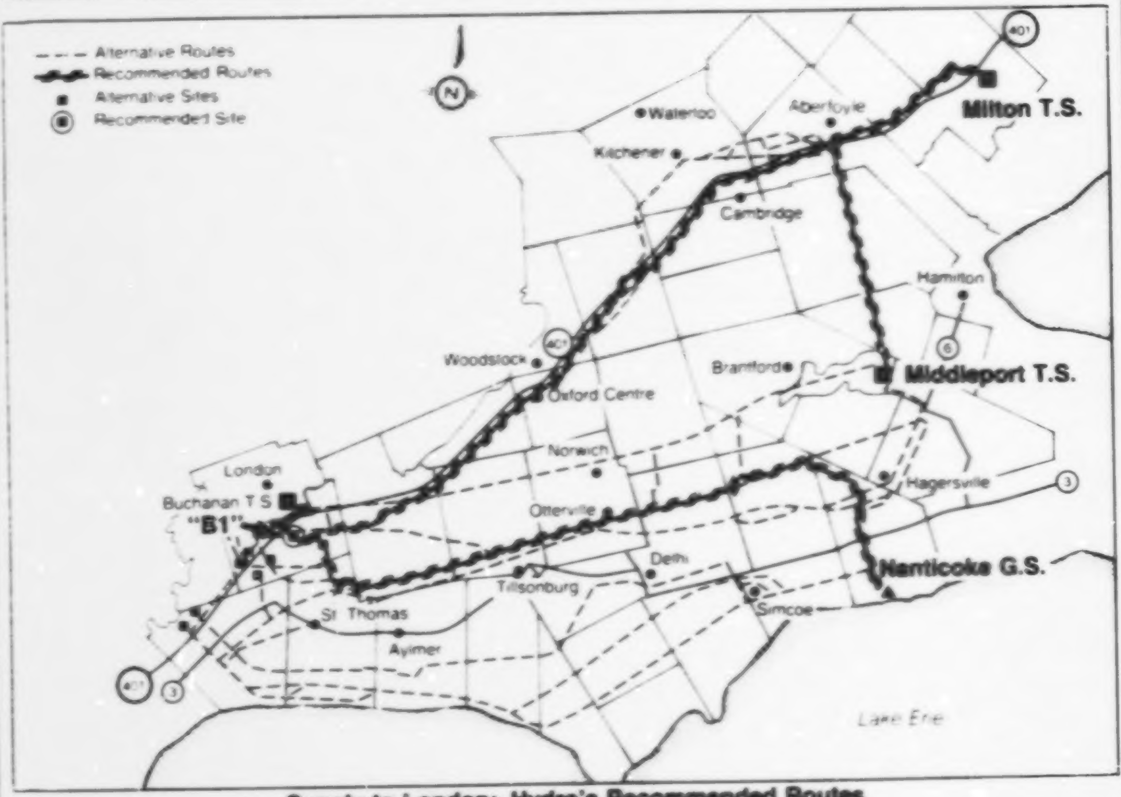
Reviewers focussed their comments on how well the EA addressed their programs and policies and the soundness of the scientific basis of the data, analysis and conclusions in the EA from the point of view of their mandate area. All reviewers thought the range of alternatives was adequate. A few disagreed with the weight given their interests and the alternative selected. Most reviewers agreed with the general methodology used, but some expressed concerns with specific parts of the data, analysis and conclusions. With regard to the requirements of Section 5 (3) of the EA Act, the Ministry of the Environment concluded that the EA considered all of them, but some concern was expressed on the manner in which they were met. No recommendations were made regarding acceptance of the EA or approval of the undertaking.

ROUTE STAGE HEARINGS

The notification procedure ordered by the Joint Board with respect to the Route Stage hearings was much more extensive than for the plan stage hearings. Three Notices were sent to all parties and participants to the Plan Stage hearings, all landowners (about 35,000) affected by all the alternative routes,


Owen Sound
Georgian Bay
Lake Huron
Chatsworth
Collingwood
Port Elgin
Stayner
Barrie
Bruce NPD
Paisley
Chesley
Markdale
Flesherton
Essa T.S.
Angus
Elmwood
Durham
Dundalk
Alliston
Walkerton
Hanover
Shelburne
N
Alternative Routes
Recommended Route

Bruce to Essa: Hydro's Recommended Route


Alternative Routes
Recommended Routes
Alternative Sites
Recommended Site
N
401
Milton T.S.
Waterloo
Aberfoyle
Kitchener
Cambridge
Hamilton
6
401
Woodstock
Brantford
Middleport T.S.
Oxford Centre
Norwich
London
Hagersville
3
Buchanan T.S.
"B1"
Otterville
Delhi
Nanticoke G.S.
Tillsonburg
Simcoe
St. Thomas
Aylmer
401
3
Lake Erie

Supply to London: Hydro's Recommended Routes

FIGURE 7

municipalities, special interest groups and many others. These notices mailed in August 1983, November 1983 and January 1984, contained progressively more detail information with the final notice showing the recommended location to the facilities and attaching the summary of the Route Stage EA. In these notices, a February 1984 date was set for the preliminary Route Stage hearings to commence.

In late 1983, several parties approached the Joint Board to request permission to review the Plan Stage decision. The Board adopted the procedure that "leave" was required to tender evidence only relevant to the completed plan stage hearings. The party was required to bring forward a notice of motion supported by an Affidavit which sets out the complete grounds for requesting such leave. This procedure was followed and hearings on this matter are taking place during February 1984. It is anticipated that the Joint Board will grant leave to hear new plan stage evidence at the upcoming Route Stage hearings.

Meanwhile, several parties, unsatisfied with the Joint Board's procedures and decisions, made application to the Divisional Court of the Supreme Court of Ontario to have the decisions of the Joint Board overturned and a new Board appointed to rehear the case. A Judicial Review was granted and 7 days of hearings before three Supreme Court judges were held during January.

The applicants' main grounds were that the Joint Board provided inadequate notice of hearings and selected a Plan (M3 modified) which was not an alternative presented and analyzed at the hearings and which directly involved people previously not affected by the six basic system alternatives. The Judicial Review panel announced on the final day of hearings that it was deferring its decision on the matter, but saw no reason to stay the preliminary hearings scheduled by the Joint Board in February 1984.

At the time of writing of this paper, it is difficult to predict the extent of new plan stage evidence which may be brought by the new parties to the hearings. It is possible this next set of hearings could extend into the fall of 1984. This would seriously extend the urgent in-service date of July 1988 for the second 500 kV line out of the Bruce Nuclear Power Development with the associated large cost penalties.

COMMENTS ON THE NEW APPROVAL PROCESS

The two key elements which make this approval process "new" are:

- The Consolidated Hearings Act 1981.
- Two stage environmental assessment.

The first element was an act of the legislature of Ontario while the second element was a decision taken by Ontario Hydro, made feasible by the first element. To date, no other proponent has chosen to use the C.H. Act in this two stage format. We understand that no other provincial agencies are currently planning projects based on the two stage EA process. As Ontario Hydro is only part way through the process on its two largest transmission projects and the same Joint Board is assigned to both projects, our experience is indeed limited.

With respect to the Act itself, no changes have occurred since its passage in 1981 and we have not proposed changes to date. The announced plan to eventually make the use of the Act compulsory rather than at the option of the proponent has not been implemented. It continues to be administered by the Minister of the Environment.

The only projects to pass completely through the C.H. Act process to date are one stage municipal public works projects. Based on the small number of cases to date, where the Joint Boards have refused approval, the Cabinet has tended to overrule the decision and authorize the project to proceed; and where the Joint Boards have approved projects, Cabinet has supported their decision.

With respect to the operations of the Joint Board on the transmission projects, it has, in the view of Ontario Hydro, conducted the hearings in an orderly and fair manner and has issued timely decisions. The "without constraint" condition has introduced an element of uncertainty in our planning which we had hoped to reduce by the two stage format. The matters currently under appeal before the courts regarding notification and natural justice could, if unfavourable decisions are rendered, have serious implications on Joint Board procedures and indeed on the two stage format. The determination of appropriate notice for protracted, progressive and large geographic undertakings such as the location process for a transmission line has always been elusive. Most people suffer from the NIMBY (not in my back yard) syndrome and will not react to notices or enter the planning process until the recommended route directly affects their property.

Three features of the C.H. Act have increased its effectiveness. Firstly, the power to defer unto itself any matters for future hearings has enabled the Boards to better organize hearings.

Secondly, the requirement for the same Board to make all the decisions through to the end has expedited the approval process by reducing the requirement to present background evidence to a new Board each time.

Thirdly, the power of the Board to make decisions rather than recommendations has helped to get matters settled faster.

In summary, some problems have surfaced and some advantages are indicated, but experience is too limited to draw an overall conclusion. The C.H. Act has an exciting potential to streamline the approval process but it needs to be given a chance to see if it will live up to this potential.

REFERENCES

1. "Environmental Assessment of Provincial/Regional Power Planning Schemes" by G.L. Wortman, Ontario Hydro, March 1983.
2. "Plan Stage Environmental Assessment - Southwestern Ontario" Volumes I, II, III, IV and Summary by Ontario Hydro, October 1981.
3. "Review of the Southwestern Ontario Plan Stage EA" by the Ministries and Agencies of the Provincial Government, December 1981.

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PERSPECTIVES ON SITING ADVISORY COUNCILS IN PUBLIC PARTICIPATION UTILITY PLANNING

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ABSTRACT

Public participation in the electric utility industry, notably in the form of an independent siting advisory council (SAC), is widespread and can work to minimize conflict. The enlistment of regulators, local officials, business groups and other interested parties early on in the process of siting controversial facilities has become common practice. This has come about in part due to the awareness on the part of industry that the public has a proper role. Such public participation programs can be extremely useful as an educational process, in identifying public values, and in developing an understanding of, and trust in, a common cause. However, open planning is not a panacea that eliminates all potential conflict from a utility's dealings with the public and with the various regulators.

Siting advisory council programs can be costly--in terms of dollars, time and aggravation. Once a utility commits to using a SAC, it sacrifices part of its own decision-making power. In addition, the firm, assumes an obligation to consider diverse opinions, often resulting in slowing the process of reaching decisions to a snail's pace. On the other hand, the SAC members must make a commitment to such programs and, in doing so, may take on peculiar liabilities. This is particularly true of members affiliated with regulatory agencies when conflict of interest is but one potential liability.

Mutual understanding of, and belief in, the purpose of an independent advisory council is perhaps the most important factor in laying the groundwork for a successful program. The concept of public participation has undeniable merit; however this merit alone does not guarantee success. The key to a successful public program is the establishment and maintenance of credibility through trust-building.

This paper presents the rational for using independent siting advisory councils on controversial projects, and also, as illustrated through the experiences of the authors, some pitfalls that may be encountered.

INTRODUCTION

Anyone who reads a newspaper knows there is tremendous difficulty in developing new large scale projects. Human health and environmental concerns, regulations, and public opposition have made the process difficult. As a nation we face an increasing dilemma how to handle the vast array of development projects that are regionally or nationally needed or desired, but which are objectionable to many of the people who must live near them. Facilities associated with electricity generation such as power stations, waste disposal sites, transmission and railroad corridors and the like, are all considered Locally Unacceptable Land Uses or LULUs. While there are those individuals who will always say "not in my backyard", the difficulty of more thoughtful people comes in trying to balance the need for the facility with a wide variety of environmental, social, and economic issues.

The public hearing process has been adopted by most planning, development and regulatory agencies as the mechanism for assuring that competing interests and viewpoints are adequately addressed in any new development proposal. However, the hearing process generally occurs long after site decisions have been made, therefore the hearing is one of carefully prepared written statements and there is little or no interaction between groups. As a result, polarization between interest groups can be, and often is, reinforced through the hearing process. There is seldom a feeling of mutual concern for achieving the best solution in the highly charged atmosphere of the hearing process.

Public participation in the form of an independent advisory council in the electric utility industry is becoming widely recognized as a helpful precursor to the hearing process to minimize conflict. It can be extremely useful as an educational process, in identifying public values, and in developing an understanding of, and trust in, a common purpose. However, open planning is not a panacea that eliminates all potential conflict from a utility's dealings with the public and with the various regulators.

This paper discusses the use of public participation and specifically the use of independent siting advisory councils on controversial projects, and also, as illustrated through the experiences of the authors, takes note of some limitations that may be encountered.

PUBLIC PARTICIPATION AND SITING ADVISORY COUNCILS

A good public participation program typically has three primary goals. These are:

Credibility - By creating a visible decision making process to which everyone has access, public involvement provides a means of making the decision making process credible to groups with highly divergent viewpoints

Identifying Public Concerns and Values - Because the various groups have fundamentally different points of view, they will evaluate any proposed action from different perspectives. Public involvement provides a mechanism by which a utility can understand the problems, issues, and possible solutions from the perspectives of the various interests.

Developing a Consensus - One implication of the highly divergent public viewpoints is that there is no single philosophy on which there is a consensus that can guide all utility actions. Rather, consensus must be formed on an issue by issue basis. Public involvement provides a process by which such a consensus can evolve around specific utility actions.

There is no concensus definition as to what constitutes a public participation program. To be classified as truly "participatory", such programs should include an element of sharing in a decision to be reached. Existing and earlier utility programs range from public opinion polls, informational meetings, and citizen action phone lines, to interactive discussions with Boards of Directors and high-ranking corporate officers. The "participatory" power of each of these programs varies.

In the last few years, a number of useful social science techniques which have the potential for facilitating group interaction in achivement of the goals - developing credibility, eliciting values and concerns, and arriving at a concensus, have become available. The use of such techniques can permit the utility planner to obtain public participation at an early design stage, thereby helping to reduce or even eliminate the conflict which has become so characteristic of the later stages of modern large scale development.

The use of siting advisory councils (SACs) in the siting process has gained increasing attention as a useful forum for inclusion of diverse viewpoints in a complex decision process. Participants act as jurors in the process of developing selection criteria and possibly in assigning values or levels of importance from one criterion to the next.

LIMITATIONS

The benefits of using siting advisory councils in site selection have been documented numerous times by numerous authors. While these benefits are supported by the authors of this papers, experience has shown that there are limitations to the use of such groups in the planning process. Once such limitations are recognized, this knowledge can greatly smooth the efforts of all involved.

The limitations are of two principal natures; timing and task. Timing is concerned with when the outside group is integrated into the decision making process. In this context, "time" is defined by the number of decisions remaining in the process, and not by calendar time.

The proper timing of involvement is to a large extent, determined by the task. The task limitations are set by the only two available choices should the group be sharing opinions or making decisions? If it is sharing opinions, the earlier the better; if it is making decisions, they should be brought in at the time of the decision, which is often late in a site selection program.

Affected by both timing and task is another question which also has imposed limitations - "who should be involved in the process?" These limitations are discussed below.

Tasks - Decision-Making or Opinion Sharing?

In terms of the goals or tasks of any public participation program on which a utility may embark, there are only two real options: opinion-sharing and decision-making. Only one can be assigned to a council. As the name may imply, in most cases a utility will seek the opinion or advise of an "advisory council." In such circumstances, there is no promise that the advice or recommendations will be followed. Of course, serious consideration must be given to the opinion offered, however the advisory council is not given or, as some may perceive it, is not saddled with the responsibility of making the decisions for the Company. If it is only opinions that are sought, and the council is truely an "advisory" council, this must be clearly announced. The structure of the council will generally be much more casual, and expectations less imposing. These opinions, however, are of importance to the utility because they offer viewpoints based on experience unique from that of the utility.

Decision making, on the other hand, is just that the group is taking on the problem of making, what are in some cases, hard choices, and the Company, by asking for decisions, is making a committment to abide by those decisions.

Which decisions can be made is also an important question - but is not as great a problem as determining the need for opinions vs. decisions. In general, they will be the softer decisions; the trade offs that have no right answer and do not transfer utility resources to special interests. They may be the gross sifting of many sites to a few, or sifting many issues to the important ones.

When a SAC is asked to have input to a final site decision there is an increased potential for credibility problems to arise. The group may be suspect of the Company's willingness to yield this decision. Because of this, it is critical that both the sponsoring utility and the advisory council clearly understand exactly what authority is being delegated. The Company may delegate the authority to make a particular decision to the council, but it cannot delegate the responsibility for this decision. Clearly, it will always remain the Company's responsibiltiy to defend this decision, whether it be made internally by a Board of Directors or externally by an advisory council.

It is worthwhile reemphasizing that the task of the advisory council must be made clear at the outset of the program. This will help to avoid confrontation and disappointment during later phases of the council's deliberations. In addition, it will help to establish the data and information requirements for the program. In short, if only opinions are being solicited, the council members may not require detailed data and information: opinions do not need to be based in fact, and personal perferences or perceptions may suffice or actually override any factual data. However, if the task is to reach a decision, then most council members (as well as the utility) will want a substantial amount of factual data, information, and documentation.

Timing of the Process

The timing of when the advisory council becomes involved with the utility is as important as the task assigned to the group. In reality, task and timing must be considered as being interrelated and as having a synergistic effect on the planning of the program.

A site selection study for an electric generating station is usually conducted in phases that include elements such as defining eligible areas, identifying candidate areas, selecting potential sites and selecting a proposed site from among primary candidate sites. The advisory council can be brought into the site selection process either very early or very late.

If the council becomes involved early in the process then their task is that of providing opinions. These opinions can be used to guide the direction of the subsequent phases of the site selection study. At such an early phase the task of opinion-sharing is preferred to decision-making inasmuch as there is very little factual data and information available on which to base a decision.

When the site selection study reaches the phase of performing detailed studies on a small number of candidate sites, then decisions must be made. The option of giving the task of decision-making to a SAC becomes a plausible alternative. The data and information needed to make "hard choices" will then be available.

An interesting aspect of the timing consideration is that as the number of candidate sites decrease, the depth of the analysis should increase. This is reasonable in that both the company and the advisory council have a lot at stake, particularly if the council is to provide a decision rather than opinion. As a result, the company needs to provide much more data and information than at earlier phases of the site selection study. This also means that the council member must devote more time and effort to understanding the material presented.

There arises, however, a delicate balance between length of time devoted by a SAC and the completeness of understanding that is required. If the council is to make a decision, they should be convened for the shortest possible time, ending at the arrival of that decision. If a utility insists that a SAC meet over a length of time that the utility feels is required, rather than that with which the council feels comfortable, then this influence can destroy the unique perspective that the SAC was to originally bring to the process.

Who Should Participate

The choice of participants depends on the task assigned to the advisory council, the timing of their participation in the site selection program, and the overall objectives of the Advisory Council Program. The new variable here is program objective.

In addition to either soliciting opinions or making decisions (again, these are the council's task), the Company may want to establish an early dialogue with regulatory agencies and interest groups. Obviously, if this is an objective then the choice of participants becomes clear.

If involvement is early in the site selection process then the most appropriate task becomes that of soliciting opinions. Inasmuch as one man's opinion is probably no better or no worse than another's, then the composition of the council may not be as important compared to other program elements. Group dynamics necessitates a certain level of awareness of the composition of the group, inasmuch as the members must feel that the council is comprised of individuals whose opinions or decisions are trustworthy and valuable enough to share. However, a careful "balancing of viewpoints" may not be critical. There should be no question of whether or not the group will adequately represent the public. As there is no guarantee that they will, it is a safer assumption that they won't. They are certainly not a statistical sampling of a population, and there is no public charter empowering any such group. The most important factor is that they are not subject to the influence of the utility. Interest in participating on an advisory council may be reflected by an individual's related pursuits, but expertise is not a requirement during opinion-sharing programs.

The composition of the council becomes very important where there are few alternative sites to choose between and the council has been delegated decision-making authority. The Company has a lot at stake at this point and should want the decision to be made by individuals having expertise in the issues to be considered and resolved. Here it is not only important to choose the "right" individuals but it is also important attempt to achieve a balance among potentially competing or opposite viewpoints. As a practical matter, a group of individuals knowledgeable of the siting issues will be easier to work with in that they will need little, if any, education.

If it is desirable to involve regulatory agency staff and members of environmental or public advocacy groups, then the question must be asked whether these council members are expressing their views or the views of the agencies and organizations with which they are affiliated? In soliciting participation from these individuals it might be best to do so in a manner that does not have them represent agencies or organizations. Rather, they would express their own viewpoints (which are probably tempered by their vocational affiliation) and not have to "clear" their positions on issues with these organizations.

When regulatory agency staff participate on a siting advisory council there is always the potential for conflict of interest. Sensitivity to this concern will vary between both agencies and individuals, and with the task and timing of SAC involvement. Even where an agency or individual has no permit review responsibilities for the project under consideration the potential for conflict of interest can still cause some individuals to withdraw from the program. This occurs when individuals have difficulty in distancing themselves from their affiliation.

The potential for conflict of interest problems for requlators also increases the closer the council comes to making a final decision. If the SAC only expresses opinions on major issues for example, very little conflict will probably arise. However, the inclusion of site specific data may raise questions of conflict. It has been the experience of the authors that it is best to avoid announcement of alternative site locations if regulators are to be involved.

A final concern on the selection of participants is whether the council should include local representation. When the council becomes involved very early in the site selection process local participation is impractical inasmuch as there would be too many potential site areas and therefore too many participants. However, when there are only four or five alternative sites being studied local representation is facilitated. This creates a unique problem in that including local participants on the council results in an announcement as to where the candidate sites are located. Extreme bias can also enter into the decision-making process. Some individuals may attempt to sway the process due to "NIMBY" desires - "not in my backyard." Maintenance of objective decision-making from such individuals becomes a tricky task for the utility's program designer.

How Open Should Open Planning Be?

This question gets right to the heart of the entire concept of public participation. No matter how well a utility company conducts a site selection study its announcement of the results (the proposed site) will catch people by surprise, create anxiety, and possibly create instant hostility. Public participation is an alternative to the "decide, announce, defend" manner of doing business. The more the public knows about the alternatives available to the company, the less hostile they are likely to become when the final choice is announced.

It was noted above that including local representation on the council amounts to disclosure of the locations of the remaining alternative sites. Superficially this would appear to present problems, particularly if the Company does not own all the sites. In reality, and on balance, it is probably a benefit in that it lets the general public know in advance that their municipality is being considered as a future location of an electric generating station. This "eases" the shock of the final announcement and probably minimizes the anxiety local residents may experience.

There are risks associated with public disclosure of alternative sites, particularly where the sites are not all owned by the Company. The most evident risk is that of land speculation. A less obvious risk is that of introducing a geographic bias into the deliberations of the advisory council. Some council members may attempt to influence the proceedings based on their perceptions of the suitability of specific sites, rather than objectively considering the criteria by which all sites should be evaluated.

On the other hand, disclosing the locations of the remaining alternative sites also presents an opportunity for the Company to go out to these communities and explain why it needs the facility and how the final choice of site will be made. It is surely better to have the Company talk directly to the public than to let the media attempt to inform the public absent all the facts.

CONCLUSION

The Siting Advisory Council is a very useful tool which, if properly structured, can help utilities in moving projects toward implementation much more effectively than the standard hearing approach. The use of a SAC must be well thought out. The trade-offs of tasks, timing and who will be involved should be clearly understood, explained to the SAC as soon as the program begins, and strictly followed.

Probably the most important benefit that can result is the collective sense of involvement generated by the process and the attitude which participants share as a result of the cross-educational process. It allows participants to transcend individual limitations and produce a group output superior to individual efforts.

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BIOGRAPHIES

Patricia Buchinsky - is a terrestrial ecologist by education. She is a member of the Environmental Affairs Department of Jersey Central Power & Light Co. located in Morristown, New Jersey. Currently she is responsible for helping direct a siting advisory council program JCP&L is using to select a new coal-fired power plant site. Prior to joining JCP&L, Ms. Buchinsky worked with an environmental consulting firm as an ecologist and site selection specialist from 1974 to 1983. During these nine years, she was involved in numerous site selection studies for nuclear and fossil fueled power plants across the United States. Some of these, incorporated the use of independent siting advisory councils.

Dennis M. O'Regan - has been educated as a geologist, with some background in animal ecology. He is presently a planning analyst with GPU Service Corporation, located in Parsippany, New Jersey and is responsible for that company's efforts in power plant site selection and site evaluation. Prior to joining the General Public Utilities System in 1978, Mr. O'Regan worked for five years with an environmental consulting firm. His responsibilities there included geotechnical studies as well as principal investigator and project manager of various power plant site selection studies in the United States and Mexico.

John Rogers - is a principal with the consulting firm of Rogers, Golden & Halpern. He has masters degrees in both the biological sciences and regional planning. Mr. Rogers has directed numerous siting studies and public participation programs for power plants, solid and hazardous waste disposal facilities, and industrial facilities along with land planning activities. Mr. Rogers has worked for utility companies, industrial developers, institutions such as the American Petroleum Institute, Argonne National Laboratories, and the Maryland Power Plant Siting Program as well as Federal, State and local agencies around the country.

DUPLICATION IN CANADIAN FEDERAL ENVIRONMENTAL REVIEWS

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ABSTRACT

Within the Canadian regulatory regime, major federal energy development projects are subjected to two sets of environmental reviews with associated public hearings. Examination of two case studies has shown that the same impacts are being addressed through both sets of independent review. Inherently, considerable time and resources are being wasted. Four alternatives to the current system of independent reviews were evaluated; two have potential for considerably improving the efficiency of environmental reviews. These include sole review by one agency and a co-ordinated approach to dual environmental reviews.

BACKGROUND

With increasing public concern over the environmental implications of resource development and the public's desire to play a role in decision-making regarding such developments, the Canadian federal government reacted accordingly. The federal Environmental Assessment and Review Process (EARP) was established in 1973 to ensure that environmental concerns were considered for all federal projects and activities. In the late 1970s the National Energy Board (NEB), which regulates Canada's energy sector, began to require environmental impact assessments as part of applications under its review. Proponents are now faced with having their projects subjected to two independent environmental reviews, each with public hearings.

The Federal Environmental Assessment and Review Office (FEARO) administers EARP. When a project is referred to FEARO for review an Environment Assessment (EA) Panel (usually consisting of four to six members) is established to conduct a review of the project. Based on an Environmental Impact Statement (EIS) prepared by the proponent, public hearings are held to provide government departments and the public with an opportunity to comment on the project, question the proponent and to relay their concerns to the EA Panel. After the EIS has been reviewed and the public hearings have been held, the EA Panel prepares a report with recommendations covering project design and implementation. The recommendations may be specific or provide general direction. They are based on whatever information the EA Panel considers relevant. The EA Panel serves as an advisory body to the Minister of Environment. The recommendations are usually passed on to Cabinet, by the Minister, where final decisions regarding the project are made. Cabinet decisions regarding a project are not made on the basis of EARP alone; completion of EARP does not release the proponent from complying with other regulations and reviews.

The National Energy Board has both regulatory and advisory responsibilities on all aspects of energy ranging from production through to utilization. When an application is made to the NEB, it is first reviewed internally by the Board. Hearings are then held which are chaired by three NEB representatives. Unlike EA Panel hearings which are informal, NEB proceedings follow a court-like procedure. Witnesses are sworn in and legal counsel is usually required to make successful interventions. If approval for the project is granted, terms and conditions are issued which proponents are legally bound to comply with during construction and operation. The NEB is principally concerned with the technical regulation of oil and gas development, utilization and conservation but it also considers environmental protection related to these activities.

The projects that FEARO reviews and those that the NEB reviews are not always mutually exclusive. FEARO and the NEB have different mandates in terms of the types, and components, of projects that they review. However, both agencies review the biophysical and socio-economic impacts associated with energy development project activities. Despite this similiar role, the reviews are not interrelated; the two sets of reviews are not co-ordinated and information is not apparently exchanged between the two reviewing bodies. Not surprisingly, this has lead to skepticism over the government's management of regulatory requirements. Furthermore , it may be questionable that the government is really acting in the public interest. Completion of the reviews and public hearings can be quite lengthy and therefore, could quite conceivably be affecting the investment climate and in turn reducing potential economic benefits. There is a need for government to critically examine the efficiency and effectiveness of holding two environmental reviews for the same project.

The Norman Wells Project (NWP) was a proposal by Esso Resources to expand production of its existing oilfield at Norman Wells, N.W.T. and bring the oil down the Mackenzie Valley to Zama Lake in northern Alberta. The Arctic Pilot Project (APP) involved shipping liquified natural gas from Melville Island in the High Arctic to the Canadian East Coast via icebreaking tanker. Both of these projects, the APP and NWP, were subjected to the dual reviews of NEB and FEARO. It appeared to the proponents, and other observers, that FEARO and the NEB were duplicating efforts - not only their own but all of the participants' involved in dual review. In a presentation to the Special Committee of the Senate on the Northern Pipeline, Mr. Bezaire, Manager, Esso Resources Canada lead the following discussion:

> Mr. Bezaire: We also have observed that there is significant overlap between some of the public reviews, hearings and meetings that take place. There are a number of different agencies and groups that hold hearings in the Northwest Territories. There seems to have been a fair amount of confusion among the residents when different bodies move through and hold hearings on different subjects. Therefore, we think that there is a substantial opportunity to combine some of these hearings and reduce the overlap.
>
> The Chairman: Can you give me an example of two or three hearings?
>
> Mr. Bezaire: For example, on Norman Wells there was an environmental assessment hearing, a National Energy Board hearing and hearings by the water board. To some extent they all looked at similar issues.
>
> Senator Lucier: They would often have the same people making the same presentation.
>
> Mr. Bezaire: That is correct (Senate of Canada 1982, p. 17:35-36).

During a speech to the Canadian Institute of Energy Don Wolcott, Chairman of the APP

> '...condemned bureaucratic reviews, conditions and roadblocks put upon Canadian projects... "Why should (the LNG buyers) deal with Canada when they know that regulatory procedures could involve delays of up to two years and still not permit delivery of any resources"... Wolcott noted that for much of the seven months that the hearing did take place, the NEB was simply going over again the evidence which had already been heard by other regulatory agencies... Wolcott said that as well as being time-consuming, regulatory hearings are also costly.' (Hatter 1982)

Reactions to dual NEB/EARP review, such as the above, lead to a study by the Environmental Protection Service examining the necessity and effectiveness of holding these two sets of reviews. The purpose was to determine whether extensive overlap was occurring, examine the participants at the hearings, compare the roles of NEB and EARP' determine who was participating in the hearings, and examine different means by which the government could improve the efficiency of environmental review.

DUAL REVIEW

Overlap

Examination of the NEB and EA Panel hearing transcripts for Arctic Pilot Project and the Norman Wells Project revealed that the same impacts and issues were being discussed in the two different forums. The differences in the information covered were minimal. Neither process was more effective than the other in terms of identifying impacts. The main difference in the hearings was the level of detail to which the issues were addressed before each reviewing body. The treatment of impacts was more rigorous at the NEB hearings. Although the same impacts were addressed at the EARP hearings, the study results indicated that projects are examined from a more detailed perspective at the NEB hearings than at the EA Panel hearings.

Although basically the same information is reviewed by the NEB and EA Panels it may be used for different purposes. Therefore the EPS study also included an examination of the final conclusions and recommendations which were made by each reviewing agency. (The NEB hearings for the APP were suspended before they were complete. Thus, the following discussion is based only on the NWP.) The results of the NEB's and EA Panel's public reviews, in terms of the ensuing conclusions and recommendations made, were similiar. None of the conclusions, terms, conditions or recommendations made by the EA Panel and the NEB were conflicting. On the contrary they reached the same conclusions and dealt with the same impacts. However, the EA Panel recommendations were conceptual or strategic whereas NEB's were more operational. On the whole, EARP recommendations centred on what environmental protection measures should be carried out, whereas NEB's terms and conditions focused on how they should be done. The NEB took its recommendations one step further - it wanted to know how environmental protection was going to be managed. Despite the varying nature of the recommendations, if they were implemented independently of each other, then the results (in terms of environmental quality) would be the same.

Interveners

The hearings associated with environmental reviews serve a number of purposes, one of which is to provide an opportunity for concerned individuals to express their concerns to the appropriate decision-makers. This opportunity may vary between hearings, in part depending on how they are run. While considering the redundancy between the hearings consideration should be given to the above factor - are the same interveners appearing before the NEB and EA Panels? The critical difference in the two review processes lies in the participants who intervene at the hearings. When the transcripts were reviewed, each participant who made an intervention was noted. The interveners were broken down into four main categories: private citizens; government personnel; technical witnesses; and interest groups. It became readily apparent that private citizens were far more inclined to participate in the EA Panel hearings and that interest groups played a stronger role in the NEB hearings. FEARO goes to great lengths to facilitate public participation. EA Panels place emphasis on gaining comments from the public - not necessarily technical or scientific comments. "What the Panel wants is a representative feedback from local residents - their opinions, in their own words, about the project in general" (FEARO 1980b, p. 6). Both technical and community hearings are held by EA Panels. "In remote or small communities that may be affected by a project, a different type of meeting, termed a "community hearing" is conducted so that the EA Panel can get the views of local residents. For such community meetings, the proponent is asked to provide only one representative. The full EA Panel may not be present" (ibid, p. 9). On the other hand, while the NEB may hold hearings in these communities, it only does so if a request is made. "The NEB, if going out, is going out because there is a firm request for that and witnesses are ready to appear and have asked the Board to go there" (Madame Thur, NEB in NEB 1982a, p. 3940). A 'consultation' as opposed to 'confrontation' approach is taken at EA Panel hearings. "Public meetings are kept as informal as possible. The aim is to establish face-to-face contact between the Panel and the people, with a minimum of go-betweens" (FEARO 1980b, p. 6).

While the NEB does not discourage participation by private citizens their hearings may be intimidating and this apparently prevents individuals from intervening. Because of its regulating responsibilities the NEB holds quasi-judicial hearings. In such a setting, the purpose of cross-examination is to find holes in the defense's arguments - leading to an atmosphere of confrontation and intimidation. The following statement, made by a private citizen, exemplifies this. "It is also kind of, perhaps insulting today, watching some of my colleagues being cross-examined "(NEB 1980, p. 8, Vol. XII A). Further, in such quasi-judicial hearings there is importance in having legal counsel representing interveners. "The NEB's procedure has not seemed to cause problems for parties as long as all parties are represented by counsel and the majority have some familiarity with the agency and its proceedings. Difficulties have arisen only when unrepresented intervenors have appeared and attempted to participate fully" (Lucas and Bell 1977, p. 61). Although it is not imperative, legal counsel is beneficial and all those who may want to participate cannot affort it. The intimidation and expense associated with intervening at the NEB hearings, along with the necessity to travel to major centres to participate, inhibits public participation as evidenced by the findings of this study.

Roles of NEB and EARP

The environmental review processes conducted by the National Energy Board and Environmental Assessment Panels fill similar roles. For the most part they examine the same environmental impacts, are both involved in the pre-construction stage of approving energy development projects, and both provide a forum for members of the public to voice their concerns. There are also fundamental differences in the roles of NEB and FEARO which are not always apparent. Differences in the purpose of each review is an important factor when considering alternatives to current dual review.

The NEB is a regulatory agency whereas an EA Panel is an advisory body (in that there is no legal backing to Panel recommendations). This underlies the major difference in the two reviews and the responsibilities they have. EARP is an investigative process whereas the NEB is adjudicative. EARP was established "to ensure that potential environmental impacts of federal projects, programs, and activities were determined in advance, so that environmental implications would be considered in the planning process." (FEARO 1980c, p. 1). While the NEB also insures that environmental impacts are given consideration in the planning of projects they are further responsible for specifying how environmental impacts are to be managed in the construction, operation and abandonment of energy developments. While the NEB review and EARP are both part of the same approval system, their environmental reviews were established for different purposes. "The results of the EARP should be a definition of the state of the environment desired (i.e. as reflected by Minister/Cabinet acceptance of recommendations) if the project proceeds. Regulatory agencies such as NEB, on the other hand, should be directed at achieving, amongst other things, the state of the environment defined by accepted Panel recommendations. This would be reflected in the terms, conditions, requirements and enforcement of licenses and permits. It is here that detailed design of projects must be subjected to detailed scrutiny" (Frith 1983).

This subtle, yet basic difference is further illustrated by the following statements made at the APP (EARP) hearings.

> "Perception of the purpose of EARP hearings has been that they are of an overview nature to determine the attraction or drawbacks of a particular project. It has always seemed to me that the concerns over details of drilling procedures, permafrost stability, sumps, etc. are the responsibility of the regulatory branches of the federal government" (FEARO 1980a, p. 389).
>
> "...we (the EA Panel) are not in a position to decide whether twelve inches of stream bed excavation is better than the blasting of a few kilometers of quarry. We would like to know, whichever method is proposed is generally and environmentally satisfactory and if there is a regulating method to make sure that it is carried out and it is within the state of the art and the economic capabilities of the company so that they would accept the method" (FEARO 1980a, p. 406).

Although the difference in purposes is apparent when reviewing the transcripts, the Boards' 'Reasons for Decision' and the EA Panel Reports, it is not evident that all of the participants are aware of the different roles. Confusion over differences and similarities in the purposes of the two reviews may, in part, be attributed to the fact that the two reviewing bodies request that the same type of information be submitted. "They ask for exactly the same information; it is just put into different covers" (Stan McKay, 1982).

As was illustrated earlier, the different roles of the NEB and EARP are reflected in the manner in which impacts are discussed at the two hearings and in the nature of the final recommendations, terms and conditions issued by the EA Panels and the NEB. By following the hearing proceedings it becomes evident that NEB's review is of a more detailed and comprehensive nature. This in turn is followed by terms and conditions which go beyond the environmental framework outlined by the EA Panel recommendations by requiring the submission of specific plans for the incorporation and management of mitigative measures ensuring environmental protection. The important point is that EARP is not regulatory like NEB reviews, it was designed to be used as a planning device.

ALTERNATIVES TO DUAL REVIEW

The last phase of the study looked at different alternatives to the present system of dual review. Because extensive (almost total) overlap is occurring there is a critical need for government to alter the present practice and improve the efficiency of identifying and dealing with environmental impacts associated with energy developments.

The status quo has minimal advantages. Although it does offer added insurance that significant environmental impacts will be identified, there are too many disadvantages and costs which plague the system. Holding two reviews does not appear to be contributing to environmental quality; information flows between the two agencies is illogically restricted as the conclusions and recommendations developed at one hearing are not used to inform and guide deliberations at the next; participants are continually confused and frustrated by dual review; federal monies and time are wasted; the economic viability of projects may be jeopardized; and the efforts of all parties are being duplicated. There is room to improve efficiency while maintaining the objective of ensuring environmental protection.

Single Window

Having a 'single window' approach to NEB/EA Panel reviews is not a feasible alternative to the current system. A single window approach would involve the co-ordinated review of environmental impacts by the National Energy Board and FEARO via joint reviews and hearings. The EA Panel and the NEB would conduct joint hearings and co-ordinate efforts in the background reviews under a co-chairmanship arrangement. This of course would only apply to areas dealing with environmental impact assessment. The EA Panel would not deal with other components of projects (e.g. tolls, tarriffs, economics) which fall under NEB jurisdiction. In effect, proponents would only have to deal with one agency as they would only have to prepare one EIS/application and deal with one set of hearings (reduced time and costs). A single window approach to environmental review would ensure that each agency would be able to concentrate on its particular areas of concern while minimizing duplication

The logistics of implementing a single window approach would be numerous and detailed: hearing format (formal vs. informal); location and timing of hearings; EA Panel/NEB composition; handling of interveners; division of decision-making powers (will NEB and FEARO each provide their own recommendations and conclusions after the hearings are held or will they combine efforts? If they do, will it lead to problems of conflict?); funding of interveners; form of EIS/application; NEB and FEARO sharing of hearing costs; etcetera. Unless there is open and strong support for this option within government and particularly, within the NEB and FEARO, then the likelihood of successfully implementing this approach will be slim. Presently, representatives from NEB and FEARO oppose consideration of this approach. Facilitating a single window approach would require quite a substantial transformation in the management of environmental reviews and this restricts the feasibility of implementing this alternative.

Split Reviews

Possibly, one agency could review the biophysical impacts associated with a project and the other agency could review socio-economic impacts. Concerns relating to engineering or technical feasibility would become the responsibility of the agency reviewing the biophysical impacts. Because of the manner in which the two hearings are held (formal vs. informal) it seems logical that under such a scheme NEB review biophysical impacts and EA Panels review socio-economic impacts. Although it may appear, in principle, that this option would reduce overlap it is doubtful that in practice this goal could be attained.

There are a number of disadvantages to this option which restrict its viability. The most notable difficulty is the fact that biophysical and socio-economic concerns are closely interrelated and it is often difficult to separate the two. "No matter how the terms are used, it is important to recognize that impacts on ecosystems, biogeochemical cycles, and the like are intimately related through complex feedback mechanisms to social impacts and economic considerations" (Munn 1972, p. 8). Because of the linkage between these two types of impacts and because of the problem of defining a division between the two, even for the sake of discussion, operational difficulties in running and coordinating the two sets of hearings would be considerable. Proponents would still have to prepare for, and finance, involvement at two sets of hearings and the time involved in gaining project approval would not be substantially reduced. Furthermore, participants who had both socio-economic and biophysical concerns would still have to attend two sets of hearings. As with the single window alternative and the status quo, 'split reviews' are deemed to be an unsatisfactory approach to reviewing energy developments in light of environmental implications.

The EPS study identified two alternatives which would reduce overlap and which could be implemented within the existing regulatory and administrative regime without significant changes. The first involves review by only one agency and the second entails a co-ordinated approach to EARP/NEB reviews.

Sole Review

Under the first option there are two possible variations - either the sole responsibility lies with the National Energy Board or it is the responsibility of the Federal Environmental Assessment and Review Office. The argument can be made for retaining either one. However, the case supporting the NEB is somewhat stronger.

The participants involved in the NEB's public hearings pursue greater detail in their examination of environmental issues than do those people involved in EARP. The NEB evaluates projects from a wider perspective than does EARP. Not only does the NEB consider environmental impacts, but it also focuses attention on supply, markets, financial matters, cost-benefit analysis, tarriffs and public interest. The result is that the NEB reviews the same information that is reviewed through EARP, and more. This fact, considered in light of the evidence that substantial overlap is occurring, provides a strong basis for advocating that the NEB conduct the environmental reviews when a project falls under the mandates of both agencies.

The advantages of having the NEB conducting the only review are many fold. Overlap and redundancy would be totally eliminated. This implies savings in cost to all interveners who appear before both reviewing bodies; government savings as one reviewing body is relieved of its responsibilities; reduced time spent in the preparation for, and participation in, hearings; and (probably) less time involved from project conception to approval or rejection. A number of representatives from the petroleum industry, who had been involved in both sets of reviews, were interviewed. The most common response was that there should only be one environmental review. Dual review is frustrating to those involved and hence, they felt a considerable amount of time and money was being misused. Reducing review to one agency would satisfy these concerns. In June 1983, a Task Force headed by V.L. Horte studied pipeline construction costs in Canada and recommended that the "EARP process should not be invoked in respect of pipeline facilities over which the NEB has certification and regulatory jurisdiction... Use of the EARP process on NEB regulated projects is an unnecessary duplication which leads to unnecessary costs" (Horte 1983, p. 52). This recommendation has not been acted upon and there is debate within government as to whether it should be. In a letter to J. Chrétien (Minister of Energy, Mines and Resources), C. Caccia (Minister of Environment) stated that while the Department agreed that overlap and redundancy should be reduced, environmental review should not be limited to the NEB's. Rather than adopting the recommendation in Horte's report, he felt that efforts should be made to co-ordinate the two reviews.

The major shortcoming associated with having the NEB holding the only environmental review, and hence the only set of hearings, is the limited participation of private citizens. Although it is likely that in instances of sole review the NEB would make greater efforts to facilitate public participation (such as holding hearings in small communities) it is unlikely that involvement of private citizens in NEB reviews would equal that in EARP.

Co-ordinated Reviews

The next option considered to be a feasible alternative to independent, dual reviews is co-ordinated EARP/NEB reviews. The two reviews would be conducted in much the same way as they presently are but with a few important strategic changes. By abandoning the practice of independent review and treating the two hearings as part of a single system with information flows between them, the identification and resolution of environmental impacts could be enhanced and the overlap problem significantly reduced.

Resource development begins with the initial concept of a project. From there, the proponent begins general planning, including the examination of alternative means of development. Assuming that the total benefits of the project outweight the costs, detailed plans are drawn up. Next is the approval process. If the project receives the go-ahead, then final designs are completed to comply with the conditions of approval and the project is constructed and put into operation. Each of these stages represents a decision point and therefore, an opportunity for government to get involved and the public to participate. As it is, EARP is being applied anywhere between general planning and up to the 'approval' stage, depending on the project. NEB reviews at the approval stage but detailed plans are not always worked out. In order to meet the widespread concerns of government and the public, involvement should begin during general planning.

The Environmental Assessment and Review Process and the environmental reviews of the National Energy Board could prove to be complementary to each other. Looking at the project continuum, it seems logical that the formal review under EARP should be applied after the general plans have been completed but before detailed planning has begun. Detailed planning needs to be completed before NEB public reviews are commenced. The goal of more efficient environmental review can be secured by holding EARP after general planning and the NEB review after detailed project planning, in conjunction with the establishment of a mechanism to facilitate flows of information between the two agencies.

Under this scheme EA Panel reviews could be used as a screening and scoping mechanism. This would not require any alternations in the way EARP is presently administered. The major change would lie in the environmental issues discussed at the NEB hearings. Rather than going over the same general concerns again, the NEB could utilize the information gained at the EARP hearings. This would give the NEB the benefit of a comprehensive review and allow its hearings to focus more narrowly on specific impacts and to determine how impacts are to be addressed in the construction, operation and abandonment of the project. This implies that the EARP hearings would have to be held early in the planning stages of a project, before the NEB hearings. The NEB would conduct its review after detailed planning had been completed allowing sufficient time to pass from the EARP hearings so that the information derived from the first review could be used for the second. This would be in keeping with the respective roles of the two agencies. As was mentioned, EARP is more of a planning tool while NEB environmental reviews are a regulatory mechanism. The specific approach and mechanisms for co-ordinated review will have to be worked out by the NEB and FEARO if the government decides upon this approach. There needs to be a clear interdepartmental understanding of what the end result of each review should be and how they should be interrelated.

If the scheme for environmental review is adopted many benefits would stand to be gained. There would be: the insurance offered by dual review that all major environmental impacts are identified; the EA Panel would serve as a screening mechanism for the NEB hearings, saving time; the NEB hearings would serve as a 'follow-up' mechanism for those who wish to pursue recommendations provided by the EA Panel; the first hearings would provide a learning opportunity for participants; two types of meetings (informal and quasi-judicial) would be held allowing participants to intervene in the setting they preferred; hearings would be held in the vicinity of the project as well as in major decision-making centres. Overlap and the time involved in hearings would be reduced; uncertainty surrounding the review processes should diminish; and frustrations stemming from uncontrolled repetitive discussions and debates during dual review would subside. Most significantly, this option could enhance the identification and treatment of environmental impacts. It is for these reasons that the Department of Environment has taken the position that in the future EARP and NEB reviews should be synchronized.

ADVANTAGES AND DISADVANTAGES OF FINAL OPTIONS

STATUS QUO

Advantages

- existing mechanism

Disadvantages

- public dissatisfaction
- relatively time-consuming and costly
- extensive overlap

SPLIT REVIEW

Advantages

Disadvantages

- public dissatisfaction
- relatively time-consuming and costly
- overlap
- difficult to implement

SINGLE WINDOW

Advantages

- overlap eliminated
- public satisfaction
- savings in time and cost

Disadvantages

- very difficult to implement

REVIEW BY ONE AGENCY

Advantages

- overlap eliminated
- public satisfaction
- savings in time and cost

Disadvantages

- potentially difficult to implement because of bureaucratic resistance

COORDINATED REVIEW

Advantages

- overlap reduced
- savings in time and cost
- enhances identification and treatment of environmental impacts

Disadvantages

- potential for initial public dissatisfaction

CONCLUSIONS

There is a great deal of public dissatisfaction, particularly within industry, stemming from the dual environmental reviews of the NEB and EA Panels. The dissatisfaction is well founded as it is based upon the duplication of efforts at the public hearings. A large percentage of the environmental issues are being repeatedly discussed from one hearing to the next. If the federal government adheres to its present practice of independent and inherently duplicative hearings, it will continue to be a source of frustration and vexation for many of those who are involved. Greater efficiency at identifying the environmental consequences of energy developments can be realized by abandoning the status quo. Although there is clearly room for improvement, there is no clear-cut, obvious route to an improved system. There is, and will continue to be, debate as to what should be done. Two options have been identified, 1) sole review by the NEB and 2) co-ordinated reviews, both of which would improve the efficiency by which government identifies and addresses environmental impacts.

Do the differences in the two reviews warrant the application of both to the same project? The NEB's and EA Panels' reviews are equally effective at identifying the environmental impacts associated with energy development projects. The NEB and EA Panels are also addressing the same impacts in their final recommendations and conclusions, but the focus of the EA Panels' recommendations and the NEB's terms and conditions are different; the EA Panels' results are advisory and the NEB's are prescriptive. Despite these differences, the application of either the NEB's or the EA Panels' recommendations to the design and operation of a project would have the same bearing on the project and the environment.

The NEB and EARP have very similar mandates and roles in environmental review. Yet again, there are differences though they are not always recognized, even by those who are involved in the reviews. This lack of apparency may be attributed to a number of factors: government has failed to clearly define the differing roles of the NEB reviews and, particularly, EA Panel reviews; EARP hearings are not always held far in advance of the NEB hearings (for the Norman Wells Project, the EARP hearings were held only three months before the NEB hearings); and much of the same information is reviewed by each agency.

The NEB is a regulatory agency while FEARO, the administrator of EARP, is an advisory agency. EARP was designed more to be a planning tool than a regulating procedure. As a result, the discussions before the NEB are more detailed (yet centring largely on the same issues), and the recommendations and conclusions made by EA Panels and the NEB differ in focus. Because differences in the roles and mandates of the NEB and EARP do not presently have any influence on the impacts which are discussed at the hearings (the discussions are the same), the variances cannot be used to justify maintaining both sets of hearings. However, if EARP was applied more as it was intended, the two reviews would have obviously different purposes.

The key difference in the two reviews is the extent to which they identify the concerns of private citizens. FEARO facilitates public participation to a greater extent than does the NEB and therefore, EARP is more effective at identifying the concerns of interested individuals. If it is decided by government decision-makers that the opportunities for public participation provided by EARP are not necessary, then it can be justified having a single agency (the NEB) review the project. However, it could be argued that public participation is an important and essential element of environmental review processes and that private citizens are entitled to adequate access to government decision-making on projects which may affect their communities and lifestyles. The elimination of the opportunities for public participation (by having sole NEB review) could result in public opposition and disquiet as a major link to the decision-making process would be removed. Further, government and the proponent may fail to benefit from the information provided by private citizens - information which may not be obtainable from technicial or scientific experts.

The question of what can be done to improve the efficiency of the identification of environmental impacts by government appears to come down to the issue of public participation. It may be viewed that public input is necessary for decision-making and that the NEB does not provide sufficient opportunity for the public to intervene. Presently, a great deal of resources, time and money are being wasted by dual review. The government must decide on the value of public participation and what trade-offs can be made between that input and improved process efficiency.

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THE MARYLAND SITE ACQUISITION PROGRAM

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ABSTRACT

The statute currently requires that the Maryland Power Plant Siting Program acquire a minimum of 1 site suitable for each of the three largest utilities in Maryland. One site has been purchased, an impasse has been reached over the purchase of one site from the Federal government, and a regional study to select the third site is nearing completion. A discussion of the history of the site acquisition program provides perspective on the capabilities and constraints on state governments in such an endeavor.

INTRODUCTION

The Maryland Power Plant Siting Program was established in 1971 to insure adequate power on reasonable schedules at reasonable costs while also protecting the quality of the state's environment. Major program elements include impact assessment for existing facilities, a research program, detailed evaluation of proposed new sites, and acquisition of sites in a state land bank. Numerous planning and technical activities support these broad functions.

LEGISLATIVE REQUIREMENTS FOR SITE ACQUISITION

Legislation initially required the acquisition of at least four and no more than eight sites, with at least one site available at any time for each of the two largest utilities in the state. The law was later revised to prevent the acquisition of sites for any utility whose peak demand is less than 1000 MWe within the state unless approved by the Public Service Commission. The acquisition schedule was also revised (in 1978) to require purchase "within a reasonable time" of at least one site for each of the three companies with a peak demand in the state of more than 1000 MWe. The actual number of sites (between 3 and 8) is required to be based on a biennal study of growth projections and site requirements. Site selection must be based on studies showing the suitability of the site. Once a site has been identified, it must be purchased or removed from consideration within two years. After acquisition of a site, the state and affected counties are to jointly identify a transmission line corridor, which should then be incorporated in the county's land use plans. It should be emphasized that utilities retain the ability to purchase sites on their own and are not required to use the State-purchased sites.

Funds for site acquisition comes from an Environmental Trust Fund, which supports the entire Power Plant Siting Program through an environmental surcharge on electric utility bills. The average surcharge during FY 1984 is 0.175 mills per kilowatt hour and should provide revenues of approximately $5.5 million in FY 1984. Sites may be acquired through negotiation or condemnation. Interim uses of a site which will not affect its availability as a power plant site are allowed and encouraged. Half of any revenues from interim use are paid to the county in which a site is located, and, at a minimum, the county must be paid an amount equal to the property taxes that were paid on the site at the time of acquisition. An electric utility may purchase a site upon request, at "fair market value". If a site is not used by a utility within 15 years from its date of purchase, the original owner or heirs may repurchase the site at a price not to exceed the original price plus 6 percent annual appreciation. No sites have been purchased from the state by a utility to date.

RATIONALE FOR SITE ACQUISITION

There are several related reasons for establishing a state site acquisition program. The first is that it promotes an early orderly development of power plant sites while allowing a systematic incorporation of public interest considerations, including public and local government participation, environmental impacts and economic development. Consideration of such factors is not precluded for utility-selected sites, but input usually occurs at a much later stage, usually at the Public Service Commission certification hearing on a specific application. Effective participation at that stage requires standing as a party, and participants are to some extent forced into a "take it or leave it" situation. The state site acquisition process in principle avoids many of these difficulties.

A second reason for site acquisition is that it provides the state with a set of alternative sites. When a utility proposes construction at a particular site, the state has some basis for judging the utility's proposal by comparing it to the sites in the land bank and by using the information developed in the studies that led to acquisition of state sites. The exercise of site acquisition also helps to educate policymakers to the idea that there are no perfect sites and forces them to acknowledge the trade-offs required to find actual sites.

A third reason for state site acquisition is that it helps utilities to eventually obtain sites which might otherwise be difficult to acquire.

A final state reason for site acquisition is that it reduces the potential for delay or bad decisions in a utility licensing procedure. In the absence of an available and evaluated alternative site, it is very difficult to oppose a proposed utility site because the delay caused by starting over would be disruptive and expensive and might even adversely affect reserve margins. The ready availability of an alternative site provides for a broader spectrum of policy options regarding power plants.

There are also disadvantages associated with State site acquisition, and the situations described above have been oversimplified. These limitations are discussed in later sections of this paper.

BRIEF HISTORY OF MARYLAND SITE ACQUISITION

There have been two fundamentally different types of site acquisition activities: In the early years of the program, acquisition activities were focussed on seemingly good sites as the opportunities presented themselves. The Program has evolved to the point where regional screening studies are currently utilized.

The targets of opportunity include Bainbridge, Elms and Stillpond Neck. In each case a preliminary study was conducted before a decision was made to proceed with an acquisition attempt, and more detailed studies were performed in parallel with or subsequent to the acquisition process.

At Bainbridge the former Bainbridge Naval Training Center was determined to be surplus and the state attempted to acquire it for a power plant as well as for various county development projects. However, several major complications arose, related to encumbrances to the title of the site due to agreements made by the Navy with a neighboring municipality at the time of purchase, federal uses of the land proposed during the protracted negotiation period, and two federal Job Corps Centers with a population of 1800 becoming tenants on part of the site. After ten years of study and effort the state has reached an apparent impasse in its efforts to acquire the site because of federal procrastination, developing incompatible land uses at and adjacent to the site and other changed circumstances.

The Elms site was acquired in 1975 in a straightforward and uncontroversial transaction, although condemnation was utilized to establish the sale price. Efforts have continued to acquire several inholdings. The state has allowed several interim uses, including tenants in rental housing, forest management, an ecological study area, hunting and a waterfront recreation area. There are no current plans for utilization of the site by a utility.

Acquisition of the Stillpond Neck site was studied and then deferred due primarily to public opposition. The site was eventually dropped from further consideration because of a lawsuit regarding the two year limit for evaluation of a site after its identification.

Two large scale siting studies have been conducted. The Eastern Shore Siting Study resulted in the eventual selection of four finalist candidates. Because of the substantial controversy occasioned by this study, the General Assembly enacted legislation which prohibited State acquisition of a power plant site for a utility with a peak demand in Maryland of less than 1000 MW (which is the case for the utility which serves the Eastern Shore). No further action was taken on the sites.

The other large scale siting study is currently underway in Western Maryland.

WESTERN MARYLAND POWER PLANT SITING STUDY

Our current practice is reflected in this study, which has as its goal the selection and purchase of a site for a coal-fired power plant suitable for the Potomac Edison Company, a subsidiary of the Allegheny Power System which serves the western portion of Maryland.

The overall objective of the study was first to define large regions in Western Maryland where a coal fired power plant would be compatible with existing resources and at the same time be consistent with the environmental, economic and other objectives of the State. Once defined, these regions were analyzed using successively more detailed information. Successive screening of smaller and smaller areas resulted in selection of specific candidate areas that could be analyzed in terms of their capability to support development of a power plant. As part of this siting process, the Power Plant Siting Program has conducted an extensive public involvement program which included the convening of a select group of community leaders who formed the Western Maryland Power Plant Siting Study Advisory Group.

The Advisory Group is made up of representatives of a number of interests, including citizens representatives from the counties, representatives of the county governments, and representatives of State agencies, utility companies, and the Federal government. The main purpose of this group was to provide the Power Plant Siting Program with information about the public and private concerns of people from each county in the study area. These concerns focussed on the kinds of factors that should be considered in selecting a site and how those factors should be used. At the same time, the Advisory Group provided us with a formal channel for receiving and disseminating information about the entire siting process to the community at large.

Each of the four stages of screening identified increasingly more specific locations for power plant sites. The four stages of the screening process included the following activities:

- Exclusionary Screening - a procedure to identify areas where power plant sites are legally or practically excluded from development;

- Discretionary Screening - A process to identify large areas (several hundred to several thousand acres in size) using available data and numerically weighted siting factors developed by the Advisory Group;

- Suitability Screening - An evaluation designed to locate and map possible candidate areas and subject these areas to a preliminary suitability analysis for site development; and

- Candidate Area Comparisons - A detailed analysis of favorable power plant areas building on previous analyses and input from technical experts and informed citizens.

In the first stage of screening 110 candidate areas were selected. After more detailed technical reviews of these areas and public workshops in each of the five counties, a second stage of screening narrowed down to about two dozen candidate areas.

In the final stage of screening, criteria were developed that would provide for between-site comparisons of the two dozen highly favorable Candidate Areas. This comparison was augmented by an even more detailed information-base and included input from the Advisory Group, public workshops, field visits, county planning offices, utility groups, and the technical consulting team. The result of applying this information to the screening process, together with preliminary engineering/economics studies, was the selection of six candidate areas targeted for more detailed candidate site analyses.

A detailed air quality analysis of the six candidates demonstrated that under present design and operation assumptions and regulatory requirements, three of the sites had to be excluded from further analysis. Additionally, an engineering and economics evaluation on tranmission line, coal delivery, and solid waste disposal systems supported the elimination of these three areas from further consideration.

We have designed the remainder of the Western Maryland Study such that the final three candidate areas will each be evaluated under the equivalent of a National Environmental Policy Act (NEPA) review. The remaining evaluation tasks involve developing a conceptual power plant design for each area, evaluating environmental and engineering-related limitations and impacts, analyzing the environmental licensing constraints and issues, and performing a full-scale socio-economic evaluation of the potential impact of the construction and operation of a power plant on each surrounding community. We expect to complete the study by Summer 1984 and to proceed with selection of one of the sites for purchase.

In order to solicit the opinions of, and to inform local residents in and around the remaining candidate areas, we have formed local groups to serve in an advisory group capacity in the local level.

FACTORS AFFECTING THE SITE ACQUISITION PROCESS

The site acquisition program has been affected by many factors discussed below, the foremost of which is that many circumstances have changed since 1971.

Annual demand growth in Maryland has decreased from approximately 8% to 3% over the last decade. The immediate consequences of this decrease are that no new major power plant construction has commenced since the early

1970's, several planned plants have been canceled, and licensing activity for new plants has almost ceased. The indirect consequences are that utilities currently do not appear to have a pressing need for new sites. In the face of a lack of perceived need for new power plants, there is little governmental or public interest in site acquisition but there is still an awareness of possible impacts when potential sites are under consideration. The result is that the problems with site acquisition are as prevalent as ever, but the sense of need which tended to counterbalance some of these problems has disappeared.

A second major change is in technology. First of all, Nuclear power is not being considered as a realistic option for new plants in Maryland at present. Mitigation techniques such as cooling towers, waste fixation and containment, intake screening, waste water recycling and dust suppression have substantially affected the impacts and acreage requirements for sites, generally reducing the impacts but, in some cases, increasing the area requirements.

A third element of change involves environmental impacts and concerns. Many issues which were previously important as real or potential impacts have been mitigated; e.g. "thermal pollution", or studied to the extent that speculation has been replaced by hard information. At the same time new environmental concerns in areas such as waste disposal have arisen, and the regulatory situation has become more formalized and stringent.

A fourth area of change is in the economics of power generation and in the perception of the importance of economics. In Maryland the early focus was on finding sites suitable for both nuclear and fossil fuel generation. Factors related to nuclear plants led to an emphasis on sites far from population centers and a lesser emphasis on differential site costs, since there was no standard for quantifying and trading off safety versus cost. Escalating energy costs and the resurgence of coal costs have led to a major change in the factors affect power system costs and an emphasis on the importance of cost in siting new power plants.

LESSONS FROM HINDSIGHT

Based on our experience and evaluation of our previous results, we have identified a number of shortcomings in our previous procedures. For example, efforts to select sites suitable for both nuclear and fossil plants can result in the selection of sites which are optimum for neither. In addition, by focussing on sites suitable for ultimate expansion up to approximately 2000 MW, we have passed over smaller but potentially desirable sites.

Another fact that has come to light is that some utility-owned sites that we have evaluated in detail and have found to be acceptable would not have survived the first level of screening of the past state study process. The reason is that in the past we have been too simplistic in our application of screening criteria. For example, the Eastern Shore Siting Study placed great emphasis on finding sites with a zero impact on important aquatic species because of the importance of Chesapeake Bay aquatic resources. The problem with such an approach is that for many specific sites it is possible through detailed design and mitigation to reduce impacts to insubstantial levels at costs that may be high by direct cost/benefit standards but which are more than offset by lower site-related engineering costs that are the traditional concern of utilities, such as transmission and coal shipment costs. This has highlighted the fact that valid site comparisons are difficult to make unless detailed study has been devoted to the alternative sites.

The state built on its accumulated experience for the current Western Maryland study by focussing solely on a site for a coal-fired power plant, by specifically screening for smaller sites as well as larger ones, and by performing progressively more detailed studies of the remaining areas as we narrowed down to fewer and fewer candidate areas at each stage of the screening process. A special effort was made to ensure that sites which would prove to be suitable, on the basis of detailed studies, were not removed from consideration prematurely due to inappropriate application of of broad-brush screening criteria.

POLITICAL CONSIDERATIONS

Ensuring that adequate electricity is available is a primary purpose of the Power Plant Siting Program in general and of the site acquisition activities in particular. Nonetheless, the site acquisition program has been a major political liability for the Power Plant Siting Program. That is not much of a surprise, given the controversial nature of the job and the public participation requirements, which guarantee an aroused public. One consequence is that the funding and mission of the entire Power Plant Siting Program, of which the site acquisition activities have comprised less than 10% of expenditures, is subject to attack as retaliation for disagreements engendered by the site acquisition program.

Another quasi-political consideration is the question of where in the site acquisition process to inform and involve the public. Early involvement allows maximum opportunity to affect the outcome, but it unnecessarily aggravates many people by offering the spectre of a power plant in their backyard whereas most of the alternatives considered early on will ultimately be removed from consideration before narrowing down to several "finalist" sites. There are valid questions regarding the fairness of causing widespread distress and/or uncertainty about the ultimate fate of property and neighborhoods. There are also direct political consequences of such distress. At the other extreme, late public participation presents the public with most decisions already made. Our practice in the Western Maryland Study has been to bend over backward to involve citizens and local officials during the entire course of the study. It is too early to draw firm conclusions, but this appears to have been painful but beneficial to the ultimate success of the project.

CONCLUSIONS

Many of the reasons in favor of a State site acquisition program remain valid. Experience has pointed the way to a number of improvements in our program which should address previous shortcomings. However, the decrease in the need for additional sites raises 2 issues. One is a a practical problem: without a perceived need it is difficult to justify a site purchase which has aroused substantial local opposition. The second is a policy issue; ie., is there a sufficient need for new sites to justify the State's involvement in site purchase? We have concluded that it is important to ensure that at least two sites, a prime site and an alternate, are available for each of the major utilities, but that it does not appear warranted for the state to have a substantial involvement in site purchase beyond that point. Therefore we recommended legislation to our General Assembly, enacted eight days ago, which provides that if a utility already owns at least two suitable sites, including existing sites suitable for expansion, then we are not required to purchase a site for that utility. The new legislation also allows us to purchase land necessary for the expansion of an existing utility-owned site, including land necessary for ancillary facilities such as solid waste disposal and access for cooling water, transportation, and transmission lines.

Facility Siting and Routing '84
Banff, Canada
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SESSION III B - PUBLIC INTEREST

THE KELLY LAKE - CHEEKYE TRANSMISSION LINE
- Anatomy of the Public Consultation Process

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THE KELLY LAKE - CHEEKYE TRANSMISSION LINE
- Anatomy of the Public Consultation Process

1. Introduction

This paper reviews the public consultation component of B. C. Hydro's planning for a 500 kilovolt transmission line in southwestern British Columbia. While the information/consultation program was effective for much of the project, in some areas misunderstandings and differences in perspective between Hydro and the public stretched the communications process to the breaking point. In these instances, however, rather than resolving differences the consultation process served a useful purpose by providing a vehicle for problem definition for subsequent resolution by regulatory or political means.

2. The Project

The project being planned is a 500 kV transmission line required for reinforcement of B. C. Hydro's transmission system in southwestern British Columbia. It would become an integral component of a grid comprised of a number of existing 230 kV, 360 kV, and 500 kV transmission lines connecting generating plants in B. C.'s interior with major load centres on the southwest coast. (See figures 1 and 2)

The transmission line would be approximately 200 kilometres in length. It was originally planned as a double-circuit line, but substantial reductions in expected long term load growth caused it to be changed to a single circuit line during the planning process. The route would traverse rugged and spectacular mountainous terrain, beginning at Kelly Lake Substation in B. C.'s southern Interior region near the village of Clinton, and travelling southwest to Cheekye Substation near Squamish on the Pacific coast, about 50 kilometres north of Vancouver. The 500 kV line would replace about 135 kilometres of existing 230 kV line, using as much of the established right of way as possible.

The mountainous terrain and deep cut valleys caused the range of suitable routes to be severely restricted. While populations along the route are relatively sparse, the limited usable land is congested with roads, rail, several existing transmission lines, homesteads, Indian reserves, villages, and ski resorts.

3. The Project Planning Process

(i) Legislative

Route selection and construction approval for major transmission lines in British Columbia must comply with certain provincial government requirements. Specifically, since 1980 major energy generation, transmission, and storage facilities became regulated under the Utilities Commission Act, which requires that an Energy Project Certificate be issued prior to construction. The B. C. Utilities Commission was also established under the Act as the agency responsible for utility regulation.

Under this Act the provincial government, in early 1982, issued a "Guide to the Energy Project Review Process". In addition to requirements for information on the project description, project justification, and environmental impacts, the guide included the provision that:

> "An Application (for an Energy Project Certificate) must contain a description of the applicant's public information and consultation program. This should include a report on public notices, meetings and workshops, and other public consultation. It should contain a summary of information dissemination, public responses, major issues and concerns, and potential resolution of such issues and concerns."

Prior to publication of the above Energy Project Review Process guide, linear projects such as transmission lines, pipelines, railways, etc., were planned in accordance with the government's "Guidelines to Linear Developments", issued in 1977 under the authority of its Environment and Land Use Committee. These guidelines were also explicit in their requirement for public information and consultation as a component of the planning process.

It should be noted that while provincial regulations call for public information/consultation as part of the planning process, they do not specify what the particulars of the program should be. The objectives, extent, and content of the public information/consultation process are up to the individual proponents to decide.

In this respect B. C. Hydro was somewhat ahead of the game, having on its own initiative in the early 1970's decided that more project information and public dialogue was essential to an effective planning process, and established the Community Relations Department with this responsibility. In fact that project planning steps eventually stipulated by the government followed closely the model developed by B. C. Hydro, thus conformity with the guidelines presented little difficulty.

Planning for the Kelly Lake - Cheekye transmission line was begun in 1979 under the Linear Guidelines, and continued in 1982 under the Energy Project Review Process. While this required some changes in terminology, the basic procedures were similar.

(ii) Corporate

When B. C. Hydro's system planning indicates that a major transmission project will be necessary at some future date, the first step is the preparation of a Prospectus, as required under the Energy Project Review Process. The prospectus provides information to the government (and the public) on the project being planned, its characteristics, rationale, and the scope of the proposed study program to be undertaken - including public consultation.

The second step is to proceed with preliminary route location and impact studies. These are done in two basic parts: (a) technical and economic; and (b) environmental and social.

The information from these studies comes together in a single Preliminary Planning Report, which evaluates the alternative basic corridor options in terms of both their technical and environmental feasibility, and identifies a preferred basic corridor, along which the final route - or right of way - would be located.

The Preliminary Planning Report then becomes the basic discussion document for public information and dialogue, as well as for preliminary review by appropriate government resource management ministries. This report also contains terms of reference for detailed environmental studies that will be required for subsequent project application. Following comment received from both the public and government ministries, a final corridor is selected for detailed route location studies, preparatory to making application for the Energy Project Certificate.

For the Kelly Lake - Cheekye project, which was being planned prior to the Energy Project Review Process, a Stage I Summary Report was published in 1981 under the provisions of the former "guidelines", and this became the basic document for public discussion.

Upon receipt of the Application for an Energy Project Certificate, the government then decides whether the project can be either: (i) approved for construction without further process, or (ii) referred to the B. C. Utilities Commission for public hearings and further review, with a recommendation sent back to government for final decision. The Kelly Lake - Cheekye project has not yet reached the application stage.

4. The Public Consultation Process

(i) Policy Context

As outlined above, while major project planning procedures preparatory to an application for an Energy Project Certificate require that there be a public information/consultation program, they do not specify its objectives or content. These are up to each individual project proponent. In this respect B. C. Hydro has developed its program with the following purpose and objectives:

Purpose - to ensure that any group or individual who is affected by, interested in, or concerned about major generating plants or transmission lines being planned is:

(a) informed about plans at an early stage;

(b) aware of the planning and decision-making process;

(c) provided with information on the project and its potential impacts;

(d) provided with opportunities to consult with members of the project planning team before final decisions are made.

The objectives of the program are:

(a) to enable Hydro to make more informed and responsive decisions;

(b) to arrive at the end of the planning process with no "surprises" for either Hydro or the public; and

(c) to identify and resolve as many problems as possible prior to formal Utility Commission hearings for project approval.

In other words, its aim is to incorporate public concerns in the planning process alongside the usual planning inputs such as engineering, environmental, financial, legal, land use, etc.

It should be noted that, contrary to the expectations of some members of the public, neither consensus nor shared decision-making are specifically sought as objectives of the program. Consensus is pursued as a highly desireable result of the program, but in some cases it will not be achieved - nor is it essential for informed decision-making. Similarly shared decision-making may be a desireable ideal, but it does not recognize that responsibility for the results of decisions usually can not be shared, and Hydro alone must be accountable to the government and its customers for its decisions. Thus Hydro's planning objectives are primarily openness, accessibility, and "no surprises" so that both sides can be fully informed preparatory to whatever decisions or actions they may take.

(ii) Procedures and Methods

The basic steps in conducting the program are as follows:

- Develop a program strategy, and a plan;
- Identify the participants (e.g. provincial political representatives, regional and local governments, Indian bands, citizen interest groups, media, schools and colleges, etc.);
- Establish contact with participants;
- Provide information on project and planning process;
- Establish procedures and clarify expectations;
- Develop dialogue on impacts and issues;
- Document public concerns and comments, and follow them through to decisions;
- Respond to public;
- Summarize and report.

In conducting its program one of Hydro's basic principles is to seek a relatively large number of small informal meetings rather than a smaller number of large meetings. While the numbers of participants may be similar in each case, the smaller meetings usually enable much more effective dialogue.

(iii) Participants

B. C. Hydro participants in the Kelly Lake - Cheekye planning process included members of the project planning team representing transmission planning, engineering design, properties, electrical operations and environmental consultants.

Externally, participants included provincial government elected representatives, officials of resource management ministries, regional and local governments (both elected and administrative), property owners, Indian bands, and private citizens.

While the actual numbers of participants was not large - possibly not exceeding a total of 300 - the social spectrum was broad, and all key interests were represented.

(iv) Information Provided

Information provided as the basis for dialogue and consultation was in three basic categories:

(a) Project-specific. This included a project Prospectus, Stage I Summary Report (e.g. Preliminary Planning Report), engineering feasibility report on route alternatives, environmental impact studies, and a supplementary report on additional route alternatives (five publications).

(b) General. This included reports on corporate system planning, general perspectives on energy planning, land acquisition policies and procedures, transmission planning criteria, biological and electrical effects of high-voltage transmission lines, vegetation management, and safety precautions re transmission lines (12 publications).

(c) Government. Guide to the Energy Review Process, Guidelines for Linear Developments (two publications).

(v) Consultation Process

During the period October 1980 to March 1983 a total of 61 meetings were held with various public groups and government officials. In addition to verbal comments and letters, nine briefs and submissions were received.

During the process 29 issues or concerns were identified and documented. These ranged all the way from corporate objectives and project justification to specific impacts of the transmission line, such as biological field effects, herbicides, visual impacts, water supplies, and right of way location.

5. The Course of Events

(i) Background

Route location for major transmission lines can be expected to cause friction between those who are planning them and those who may be affected by them. While problems may not always be resolved to the satisfaction of all concerned, the issues can usually be well defined and each side will have a clear idea of the other's viewpoint, whether they agree with it or not.

In this respect the Kelly Lake - Cheekye project public consultation process took some unusual turns. Through misconceptions, legitimate misunderstandings, and some stubborness on both sides the communication problems in some respects seemed to grow larger and more complex with increased efforts to resolve them, rather than smaller and better defined.

For the record it should be noted that this was not the case with the entire project. On the northern (Kelly Lake) segment, and the southern (Cheekye) segment communications were more effective. Following thorough discussion, community representatives appeared to be prepared to live with the transmission line so long as certain conditions regarding specific right of way locations were met.

Difficulties arose primarily in the central part of the study area, in the Pemberton-Anderson Lake segment. There were a number of reasons for this, principally arising from: Hydro's legacy of previous transmission projects in the area; the project's changing characteristics; differences in perception between Hydro and the local public on the justification for the project; and different interpretations of the role of the government in the planning process.

(ii) B. C. Hydro's Legacy in the Project Area

The study region is already heavily impacted by existing transmission lines. With the first transmission line in the 1940's, followed by new lines in the 1950's and 1960's, there are now, in one short section of the Gates - Birken Valley area north of Pemberton, four existing transmission lines: two at 230 kV, one at 360 kV, and one at 500 kV. Further south in the Whistler - Cheekye area this reduces to three lines: two at 230 kV and one at 500 kV. The valley is also impacted by a highway, a railway, and a network of logging roads. (These latter do, however, provide direct local benefit in the way of services and revenue).

The region is characterized by spectacular mountain scenery but limited usable valley land. The residents are independent by nature, and very protective of their region; particularly when decisions affecting it are being made by "outsiders".

High voltage transmission lines often intrude on the landscape with no direct benefits to local residents in terms of services or revenues, and in many instances the original lines in this region traversed properties where local power supply was unavailable. In this respect the historical existence of several transmission lines, and the somewhat heavy handed negotiations that are reported to have sometimes accompanied them, left a well of local resentment that put Hydro's planning team for the Kelly Lake - Cheekye project in a hole to start with. Despite the fact that the new line would not be an addition, but would replace an existing lower voltage line, long time residents received the news of yet another transmission line with the response "Not again! Why us? We have paid our dues! Go elsewhere and take your existing lines with you!"

As a result of public discussion a number of modifications to the right of way were proposed that would ease some of the problems of proximity and visible impact caused by the existing 230 kV line. However many residents were not interested in such "cosmetic" solutions. Not only did they reject the idea of a new 500 kV line - regardless of its location - but they also wanted the existing 230 kV line removed as well.

(iii) Changing Project Characteristics

As public discussion proceeded the ground under the planning team kept shifting.

The Kelly Lake - Cheekye project was introduced to the public in early 1980 as a double circuit 500 kV transmission line with a completion date of 1988. It was described as a system expansion project required to strengthen B. C. Hydro's transmission grid by linking two major substations - Kelly Lake in the southern Interior and Cheekye on the south coast.

In some respects justification was difficult to explain publicly because the project was not required simply to connect a specific generation project to the system, or to serve any specific load centre. B. C. Hydro's system plan at the time required that a number of potential generation projects be studied as alternatives to meet future load growth. These included both hydroelectric (Site C, Homathko) and thermal (Hat Creek, Quesnel) projects in B. C.'s interior. Kelly Lake substation was the focal point for transmitting energy from any or all of these to southern B. C. and Vancouver Island load centres. Further, the project as planned would replace one of the older 230 kV lines already in place, and it was deemed practical to re-use the existing right of way for much of the new line's length rather than create a new right of way that would be costly and difficult to acquire.

However a double circuit 500 kV line is an imposing structure at the best of times (equivalent in height to a 15 storey building) and local public reaction to this new potential intrusion on their valley was strong, regardless of its justification, or the merits of using an existing right of way.

Meanwhile, during the heat of public discussion, the circumstances that determined the size and timing of the project were changing. Shrinking load growth caused the planners to re-think the need for a double circuit line and about mid-1982 it was established that only a single circuit line could be justified. Also the timing of the project was becoming less certain as the need for new generating plants diminished. None of this, however, could be officially communicated to the public because it was part of a system plan that did not, at the time, have final corporate approval. Thus while corporate Hydro held firm officially, it became necessary to "informally" advise the local public of changes in the size and timing of the project. The long delay in formal corporate announcement in the face of obviously changing project justification only increased public skepticism about Hydro's openness and flexibility, and undermined the credibility of the project planning team in public.

(iv) Perceptions of the Problem

Hydro and local residents viewed the problem from different ends of the telescope.

In addition to studies of near term generation and transmission proposals that were directly related to the need for the Kelly Lake - Cheekye project, Hydro was studying two gigantic potential hydroelectric developments in northern B. C. on the Stikine and Liard Rivers. Either, or both, could well require a separate transmission system to reach the southern B. C. load centres that would by-pass the Kelly Lake substation and possibly avoid much of the Kelly Lake - Cheekye study area. Hydro had published preliminary information on the northern projects that indicated a possible need for a new substation somewhere in the vicinity of Pemberton (called Creekside Substation) as a focal point for northern transmission lines if they were eventually needed. In addition Hydro was investigating the potential for geothermal energy at Meager Creek, west of Pemberton.

These projects were long term alternatives that presented Hydro with different route location problems at another - more distant - time. Their presence on the horizon did, however, introduce future possibilities that alarmed local residents (more transmission lines?) but also offered a potential solution to their problem - that is, why not plan the Kelly Lake - Cheekye route in a way that would be integrated with the northern transmission lines or the geothermal site in the long term? This could not only remove the threat of a new twin circuit 500 kV line from their valley, but also enable one of the existing 230 kV lines to be removed, as planned.

This proposal made theoretical sense in the long term but would entail additional up front capital expenditures of $150 to $300 million for the Kelly Lake - Cheekye line based upon uncertain possibilities. These were costs for which Hydro could find no justification. Nor could Hydro find justification for spending money on for impact studies for such speculative and costly route options for the Kelly Lake - Cheekye project.

Thus while Hydro viewed the Kelly Lake - Cheekye transmission line as a stand-alone, straight forward solution to a specific transmission problem (e.g. connect two substations), the local residents viewed it as a small and flexible component of a large and changing system. Hydro wanted to discuss a specific project, the public wanted to discuss systems.

Thus Hydro's project staff were reluctantly "backed up" into attempting to de-mystify the complexities of electrical systems under changing future scenarios in the pressure cooker of public meetings. What appeared on the surface to be simple questions required complex answers, and any hesitations or qualifications in responding were viewed as evasions or bafflegab. Attempts by Hydro staff to restrict discussion to "the problem at hand" resulted in somewhat unfair accusations of tunnel vision or unwillingness to disclose information about some mysterious "master plan". Communications on this issue gave rise to a good deal of exasperation on both sides as each sought to relate the general to the specific, or the specific to the general.

Hydro eventually took the view that while it would be fully prepared to discuss the complex matter of total system planning and project justification in complete detail, with all the necessary technical data and professional judgements, for the B. C. Utilities Commission, it could not do so for every questioner along the way. In other words, a full performance with full supporting cast, but in one place at one time.

Local residents were asked to wait in good faith, and in the meantime get on with discussing specific project impacts and available location options within the context of the study parameters established by Hydro.

The local residents' view was that the regulatory hearing came too late in the game - that justification should be established at the beginning of the process, not the end. They were concerned that any cooperative discussions with Hydro on "how" the project should be done would put them at a disadvantage during later hearings on "whether" the project should be done.

(v) Citizens and Governments

Dissatisfaction with the planning process led local residents to seek a referee well in advance of the involvement of the B. C. Utilities Commission.

Soon after public discussion began the combination of: (a) local concerns about the project; (b) public dissatisfaction with the project rationale; and (c) Hydro's unwillingness to seriously consider costly route alternatives that would avoid Pemberton and the Birkenhead and Gates Valleys, led to the formation of a citizens' coalition call PERC (Public Energy Review Coalition) as the focus for local residents' opposition to the project. This group was adept at obtaining publicity directed at discrediting Hydro for its seemingly narrow view of the situation, and its apparent lack of responsiveness to their concerns and proposals.

Eventually the PERC group, in seeking more information and different solutions, formed a "public advisory committee" - comprised primarily of PERC members - to represent local residents. The objectives of this group were to have more in-depth meetings with Hydro on a regular basis, ostensibly to obtain more detailed information, improve communications, and act as a link between Hydro and the community.

While Hydro staff were prepared to meet with this group at any time to continue project discussions, they were reluctant to recognize its special status as a "public advisory committee" in the role to which it had laid claim. This stance put Hydro in a somewhat awkward position because it has publicly supported the concept of public advisory committees as having a positive role in the consultation process, but only under certain conditions. These conditions are that advisory committees:

1. Should not by-pass elected officials, but be appointed by them.

2. Should represent a broad cross-section of the community.

3. Should be non-adversarial.

4. Should not necessarily require proof of project need to perform their function - which is to advise on "how", not "whether", a project should be planned.

5. Should be advisory only, and not expect to share in decision-making.

6. Should not necessarily have access to special information that is not also available to the public at large.

7. Should not expect Hydro to meet with them mutually exclusive of other interest groups in the community.

8. Are more useful in dense urban areas with large populations than for linear developments where small populations live in separate pockets within a large study area. Committee members from separate communities would have to travel long distances for meetings and would have difficulty advising on specific impacts in other areas.

Because the Kelly Lake - Cheekye advisory committee appeared to Hydro to be a self-appointed committee (independent of an elected body), unrepresentative of the "community at large", with adversarial origins, concerned primarily with whether (not how) the project should be planned, it did not fit Hydro's perception of an advisory committee. Hydro did, however, agree to meet with the committee at any time on the same basis as any other public group in the project area.

Hydro's reluctance to grant special advisory committee status was interpreted by the Committee as a refusal by Hydro to meet with them, and the resultant publicity exacerbated the widening communications gulf.

It was about this time that the PERC group sought and obtained a meeting with provincial government officials responsible for administering the energy project review process on the grounds that Hydro was not planning its project in accordance with government requirements. The meeting was held in Victoria in mid 1982 and included government staff and PERC representatives, the PERC group with legal counsel as its spokesman. Hydro project staff attended also, ostensibly as "observers". The meeting quickly focussed on the public consultation program, it being inferred that Hydro was not meeting its obligations as required by the Energy Project Review Process.

Because the meeting was billed as a review of the planning process only, Hydro staff responsible for the public consultation program were not in attendance. Thus one opportunity was lost to clarify that despite lack of consensus the program's primary objectives (full disclosure of relevant information, full public access to the planning staff, no "surprises" at the end of the planning process) were, despite disagreements, being met. The result was that government officials encouraged Hydro to recognize the advisory committee as a useful bridging mechanism to achieve "consensus". Hydro reiterated its willingness to meet with the committee, but under the circumstances of its structure and origins continued to resist granting special status.

Events by this time had reached a mutual stand-off between Hydro and the PERC group.

In the fall of 1982, again with legal counsel as spokesman, the PERC group succeeded in obtaining an audience with the provincial governments' Environment and Land Use Committee - a senior cabinet committee consisting of nine cabinet ministers. Hydro representatives were not in attendance. However the outcome seemed to be that the PERC group was advised to go back and work through elected regional officials. The net result was a more broadly based group, established as a committee of the Regional District - an elected body - without legal counsel.

This outcome effectively removed Hydro's concerns about the structure and accountability of the committee, and a meeting was subsequently arranged at which mutually acceptable terms of reference were developed.

It was also about this time (early 1983) that the need for the project was deferred by several more years owing to reduced load growth forecasts, and planning activity was suspended.

6. Conclusions

The foregoing outline appears to dwell more upon the difficulties associated with public dialogue than it does with solutions. In fact, many of the problems with public acceptance, right of way location, and project impacts were on their way to resolution through constructive public dialogue and responsive planning by

Hydro's project staff and consultants. However as with most events in day to day living, only the proportion that produced sparks "made the news".

This relatively small proportion is, however, relevant for analysis because it is the part that creates difficulties for both sides in a dialogue. Also small things can have significant consequences, and frequently signal larger problems ahead - or provide opportunities for doing things better.

With regard to the Kelly Lake - Cheekye project, three conclusions can be reached.

First, better bridging mechanisms are needed at an early stage in planning. On future projects, Hydro Community Relations staff should be alert to circumstances requiring special forums for dialogue (such as Advisory Committees) and initiate steps with local elected officials to establish a mutually acceptable format before positions become entrenched.

Second, the tendency to attempt to limit detailed discussion to specific stand-alone projects sometimes creates more problems than it resolves. In this respect more corporate effort should be directed towards providing clear written explanations, in layman's terms, of how the electric system planning process works, the kinds of judgements that must be made, and how specific projects fit within a total system.

Third, project planning staff can not always be expected to publicly explain and defend total system planning decisions and policies for which they are not responsible. Senior planning staff therefore have a stronger role to play in support of project staff, subject to the condition that effective forums (e.g. not large public meetings) can be developed in which this can be done.

In general, it is clear that there is no way to tiptoe past the graveyard. Controversial projects cannot escape close scrutiny by the public. The only question is when the scrutiny will occur - early in the process when feathers are relatively unruffled, or late when positions are entrenched and further studies, delays, or design changes can be costly and embarrassing.

FIGURE 1

KELLY LAKE — CHEEKYE TRANSMISSION LINE
STUDY AREA

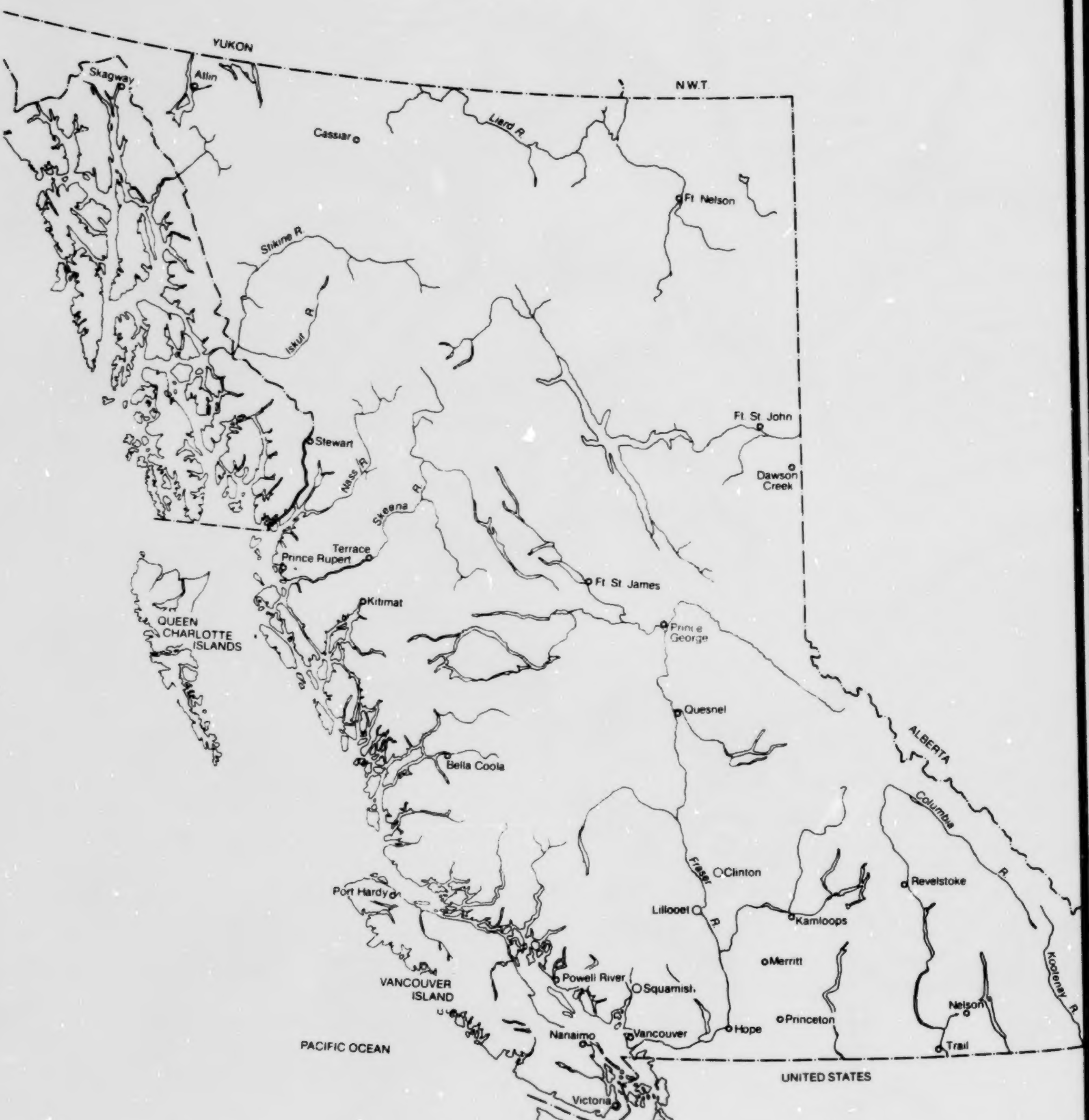
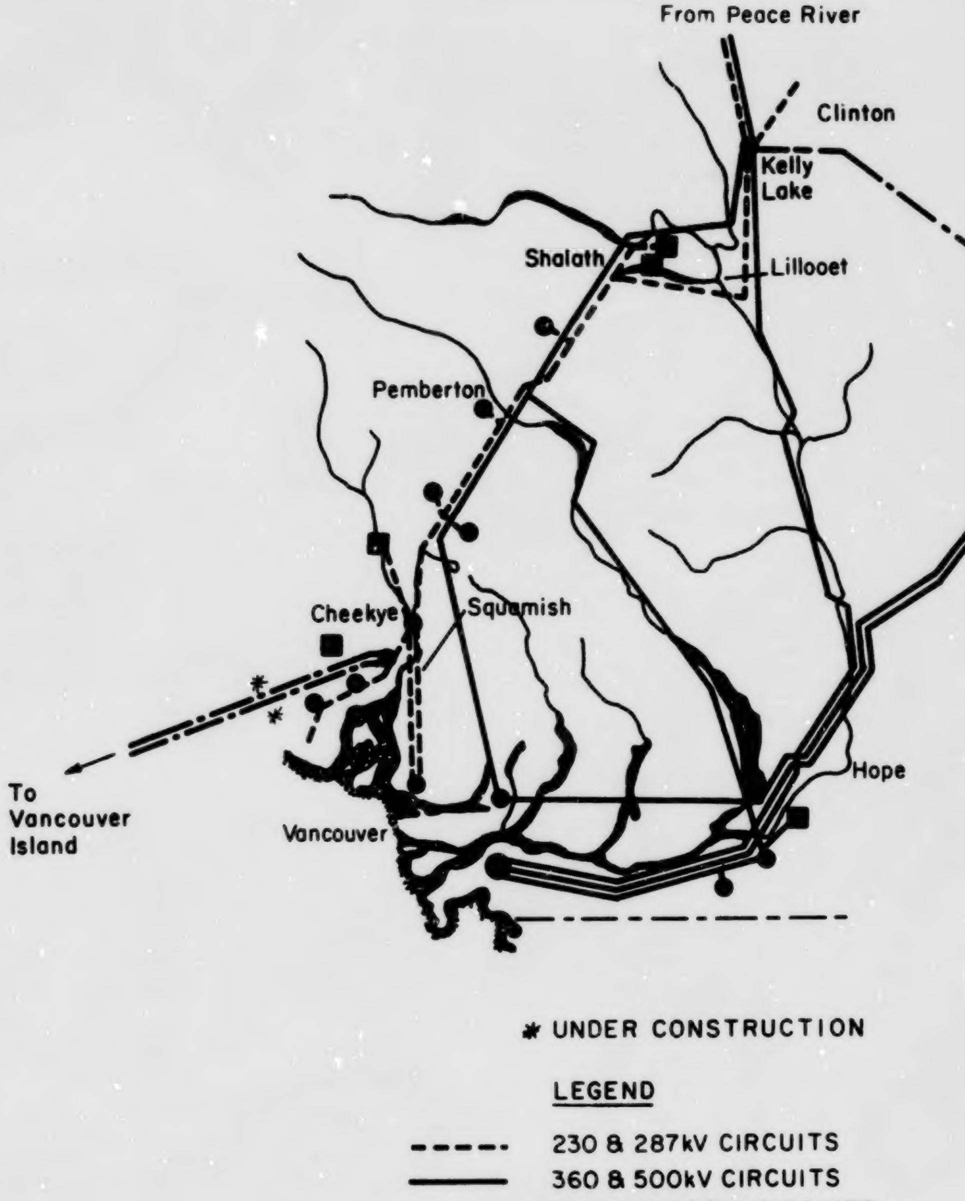

YUKON
Skagway
Atlin
N.W.T.
Cassiar
Liard R.
Ft Nelson
Stikine R.
Iskut R.
Stewart
Nass R.
Ft St John
Dawson Creek
Skeena R.
Terrace
Prince Rupert
Kitimat
Ft St James
Prince George
QUEEN CHARLOTTE ISLANDS
Quesnel
ALBERTA
Bella Coola
Columbia R.
Clinton
Fraser R.
Revelstoke
Port Hardy
Lillooet
Kamloops
Merritt
Kootenay R.
VANCOUVER ISLAND
Powell River
Squamish
Nelson
Princeton
Hope
Vancouver
Nanaimo
Trail
PACIFIC OCEAN
UNITED STATES
Victoria

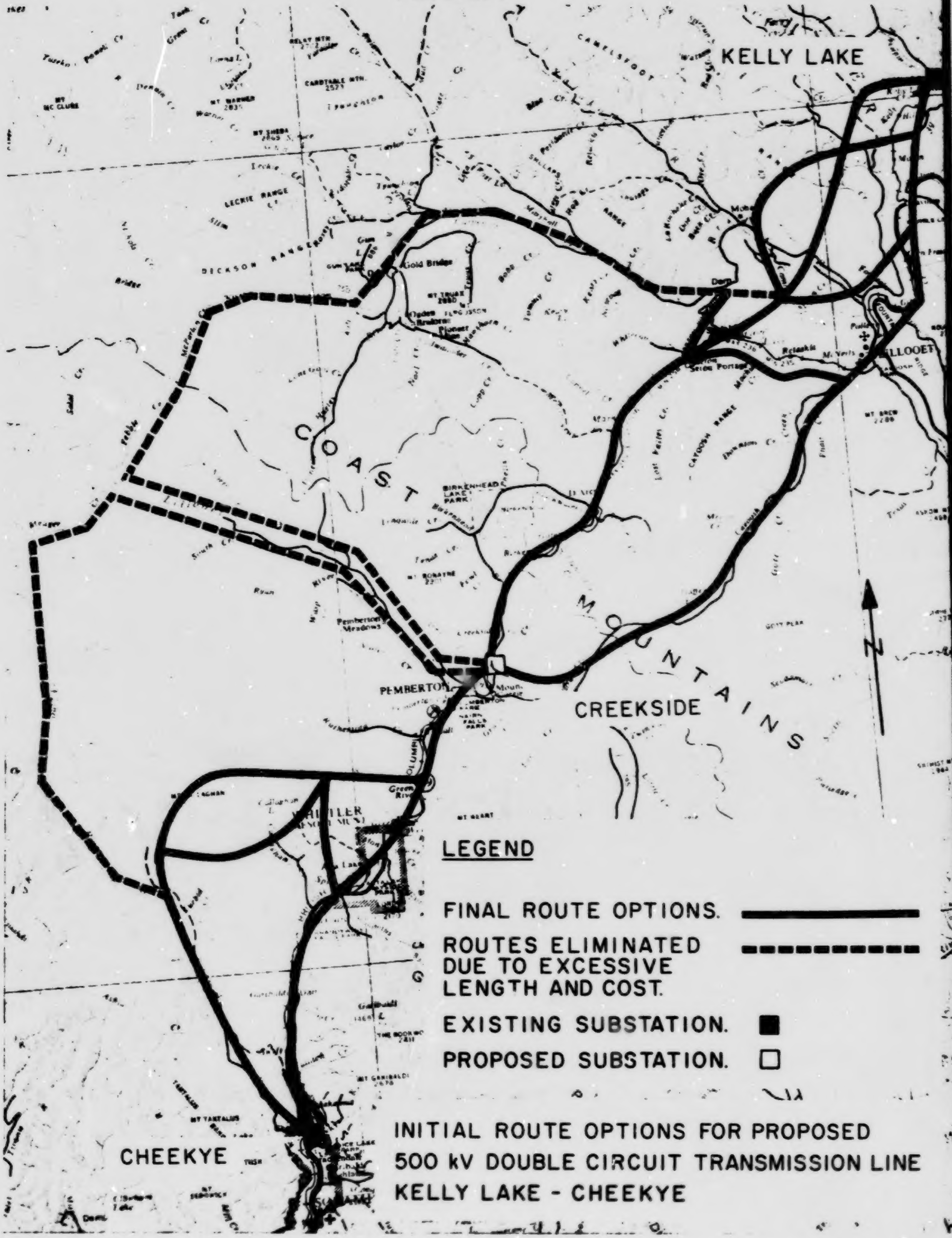
FIGURE 2

B.C. HYDRO
LOWER MAINLAND TRANSMISSION GRID
INCLUDING LINES UNDER CONSTRUCTION


From Peace River
Clinton
Kelly Lake
Shalath
Lillooet
From Mica
Nicola
Pemberton
Cheekye
Squamish
To Vancouver Island
Vancouver
Hope
* UNDER CONSTRUCTION
LEGEND
230 & 287kV CIRCUITS
360 & 500kV CIRCUITS
FUTURE 500kV CIRCUITS
SUBSTATIONS
HYDROELECTRIC GENERATION

DC/KR
3UN81

FIGURE 3


KELLY LAKE
LILLOOET
COAST MOUNTAINS
PEMBERTON
CREEKSIDE
WHISTLER
CHEEKYE
N
LEGEND
FINAL ROUTE OPTIONS.
ROUTES ELIMINATED DUE TO EXCESSIVE LENGTH AND COST.
EXISTING SUBSTATION. ■
PROPOSED SUBSTATION. □

INITIAL ROUTE OPTIONS FOR PROPOSED
500 kV DOUBLE CIRCUIT TRANSMISSION LINE
KELLY LAKE - CHEEKYE

A QUESTION OF BALANCE: PUBLIC PARTICIPATION IN ENVIRONMENTAL ASSESSMENT

Dale Ferns
Ontario Federation of Agriculture

ABSTRACT

Since the mid-seventies, various frameworks have existed at both the Federal and Provincial levels, requiring environmental approval for specific class projects. Our failure to develop a systematic approach to public participation and resolve the outstanding issues of public notice, form of involvement as well as funding, continues to comprise the entire environmental assessment process.

This paper reviews the approaches adopted and their inherent weaknesses. An appraisal is made of three case examples involving Ontario Hydro, TransCanada Pipelines Limited and the Ontario Ministry of Transportation and Communications.

It is suggested that Ontario Hydro's approach to public participation makes this Crown Corporation a clear leader.

INTRODUCTION

The seventies ushered in major changes to our traditional decision-making process. Our traditional way that served corporate and private interests so well in the preceding decades could not, when confronted with public demands for involvement, adjust.

Too often, development decisions were made exclusively on the grounds of favourable economic analysis, engineering or technical studies and just as often did not address the legitimate concerns of the public involved. Examples were numerous, but included utility and transportation projects where proponents utilized the best in Federal and Provincial expropriation legislation to push ahead projects regardless of local impact and concerns. It was a period that left its mark on society.

The public grew cynical that neither government nor corporate interests had the capacity to incorporate their concerns into the decision-making process. As a result of constant public pressure and the continual need to appoint special commissions and hearings, it became evident that a new process was needed. It was accepted that the traditional way was too inflexible, too narrow in scope, and based too much on in-house exercises to provide the public with a significant role in the decision-making process.

As an alternative decision-making process, environmental impact assessment (E.I.A.) was embraced. The process offered opportunities to both the proponent and the general public to assess alternatives, address the concerns of society and choose the best course of action. Although the process itself did not explicitly incorporate public participation as a fundamental and required step, it did clearly encourage the public's involvement.

ENVIRONMENTAL ASSESSMENT: A GENERAL OVERVIEW

It is necessary to review briefly the various approaches that have been adopted to undertake environmental assessment, if the role of public participation in this process is to be defined clearly.

Essentially, there are two general approaches to environmental impact assessment. The first approach encompasses policy statements and guidelines, while the more preferred approach from the perspective of public interest groups relies on legislation.

In the case of guidelines and statements, a number of examples may be cited, including the Federal Government's Environmental Assessment Review Process (E.A.R.P.) which has been in effect since 1973. The legislative approach is exemplified by Ontario's Environmental Assessment Act passed in 1975 and still felt by many to be a major and comprehensive piece of environmental legislation.

In addition, environmental impact statements E.I.S., which in our view, should not be confused with E.I.A., may be required by regulatory authorities such as the National Energy Board or the Ontario Energy Board. Proponents are required to undertake and file comprehensive inventories on the impact of their proposals and mitigating measures to be undertaken.

In each case, the intention of the approach whether guidelines, an order, regulation or rules of procedure and practice of the approval authority or legislation is to ensure that the decision-maker is provided with the widest possible information base, that all options have been considered, their impacts determined and addressed.

Clearly, the ultimate goal of this entire process is the selection of the best possible option which addresses in balance the economic, social and environmental needs of the public, as well as the legitimate development goals of the proponent. It is also clear that the public has an important and fundamental role to play, if the process is to work to the benefit of all parties.

The Federal Approach

As noted earlier, the Federal Government adopted a systematic approach to environmental assessment as early as 1973. Prior to the adoption of E.A.R.P. such reviews were sporadic.

The Federal approach ensures that the following three goals are achieved:

(1) That environmental effects are taken into account early in the planning of new Federal projects, programs and activities.

(2) That an environmental assessment is carried out for all projects which may have an adverse affect on the environment before commitments or irrevocable decisions are made. Projects with potentially significant environmental effects are submitted to the Department of Environment for review.

(3) That the results of these assessments are used in planning, decision-making and implementation.

Unfortunately, the process restricts the role of the public to the hearings stage. In fact, the Federal agency initiating or sponsoring the projects may as an in-house decision, by-pass the public by declaring the project has no significant environmental affects. The public's role during this crucial phase of the process is very limited.

Amendments are continually being made, however, it is unlikely the process will be incorporated into legislation in the forseeable future.

Clearly, the Federal process is narrow in application and far too limited to provide a meaningful vehicle for public involvement. Fundamental changes would be required to the process to meet the minimum standards essential for public participation.

The Provincial Approach

In 1975, the Ontario Provincial Government recognized the opportunities inherent in the environmental assessment decision-making process and passed a comprehensive form of environmental legislation incorporating this process.

The purpose of Ontario's Environmental Assessment Act, as stated in Section 2 of the legislation is, "the betterment of the people of the whole or any part of Ontario by providing for the protection, conservation and wise management in Ontario of the environment."

Unlike Federal E.A.R.P., this legislative approach requires public notice to be made following the Ministry of Environment's review. The actual timing of this notice is not clear, but public notice is mandatory which is an important improvement over the Federal approach.

Following public notice, submissions from interested parties may be made to the Minister. If a request is made for a hearing or the Minister feels a hearing should be conducted, the proposal is then referred to the Environmental Assessment Board for a public hearing.

In the event additional approvals are required as a result of other legislation, then the proposal is referred to the Consolidated Hearings Board for one hearing. This includes approvals required by; Environmental Assessment Act, Environmental Protection Act, Expropriations Act, Municipal Act, Municipality of Metropolitan Toronto Act, Niagara Escarpment Planning and Development Act, Ontario Municipal Board Act, Ontario Water Resources Act, Parkway Belt Planning and Development Act, Planning Act, Regional Municipality of Ottawa-Carleton Act, Regional Municipality of York Act. This legislated process eliminates the need for multiple hearings under various Acts and as a result, reduces expense and time delays for all parties associated with multiple hearings. However, it also makes the involvement of the public in the early stages of the development process even more crucial. Failure to participate by the public leaves them with no other forum to debate the proposals.

The Environmental Assessment Act also provides for a streamlined approval process for minor projects termed class projects. Class projects are characterized by the following conditions; (1) occur frequently and apply to existing facilities or minor new developments, (2) result in predictable and minor environmental impacts, (3) result from common and identified needs and deficiencies and (4) the process of construction and implementation is the same.

The stated purpose of class environmental assessments is to specify a planning process which will ensure that environmental effects are taken into account and approval gained without the necessity of undergoing public examination and an E.A.B. hearing. In effect, this procedure allows for full environmental assessment without public involvement on specific projects. However, proponents using this process generally incorporate public notice to add a measure of fairness.

The Class Environmental Assessment Process also involves provisions to permit the project to be bumped up to full environmental assessment requiring a public hearing. This may be accomplished by the general public requesting individual environmental assessment, by the proponent, in the event unexpected environmental impacts were identified during the initial E.A., or by the Minister.

The major problems associated with class assessments are; (1) the limited involvement of the public in the process, particularly in determining whether the project should undergo individual E.A., (2) the reliance on the proponent and the Ministry of Environment to decide what is severe environmental impact, and (3) the problem of adequate public notice.

Unfortunately, the role of the public under Ontario's Environmental Assessment legislation is poorly defined. The Act makes no provision for and does not explicitly require public involvement for individual or class environmental assessments. The public is afforded only the opportunity to participate at the approvals hearings, if one is required.

Other Approaches

Unlike public undertakings at either the Federal or Provincial level, private development projects are exempt from the E.I.A. process. However, in the case of national or provincial utility companies, regulatory authorities do require detailed environmental information to be filed.

In the case of national utility companies such as TransCanada Pipelines Limited, the National Energy Board (N.E.B.) requires under Part VI of the Board's Rules of Practice and Procedure, that proponents file detailed environmental information on the proposed route as well as the alternative routes considered. Information required includes physical data on soil, plant, wildlife and water resources, as well as information on current land use, planned use, settlement patterns, and land capability. In addition, the proponent is required to file information on the measures to be taken to mitigate impacts and their assessment on the residual impacts.

The N.E.B. does not require the applicant to involve the public in the development process, but does require that the applicant provide notice of the application to the public. The manner of such notice is left up to the applicant, but is closely reviewed by the Board in order to ensure fairness.

Unfortunately, by not requiring public involvement, the proponent is left in the position of determining the scope and support of such involvement. In the event of an in-house decision, the proponent's objectives will likely determine the form of public participation. This is a crucial point because it leaves the proponent in a difficult and extremely vulnerable position if the program selected is viewed as inadequate by the public.

In Ontario, Provincial utilities, except Ontario Hydro, are regulated by the Ontario Energy Board (O.E.B.). In these cases, the Board requires that all applicants adhere to Board environmental guidelines.

The guidelines specify the data to be collected and filed, provides basic routing guidelines, as well as construction practices to the applicant. In addition, the Board appoints an inspector to ensure the applicant complies with Board terms and conditions.

As a direct result of O.E.B. guidelines and in recognition of the need to reassess environmental practices, most utility companies in Ontario have undertaken extensive programs involving the public to identify construction problem areas and their correction, in addition to contacting the public before proceeding to the approvals stage. These initiatives are still in their infancy, but they do represent positive responses to the demands being made by the public.

The O.E.B., however, does not require that the public participate during the development or approval stage, nor does the Board provide financial support for public intervenors either directly or by awarding costs.

Summary

Although public involvement in the environmental assessment process is not required, it is apparent that it is to the benefit of all parties that public participation play a major role in the decision-making process. The general goodwill of all proponents to address the question of public involvement and its level must be recognized as positive support for such undertakings. However, by failing to address the key remaining issues of proper notice and funding, we risk compromising public participation as a meaningful exercise and with it, the environmental assessment decision-making process itself.

Public Participation Issues

There are four major issues that compromise public participation and with it, the environmental assessment process.

The first problem concerns providing adequate public notice, the second, access to information, the third, financial support for public involvement and the last, the issue of confidentiality.

Public Notice

The issue of providing proper public notice to all parties is considered essential. Generally guidelines, or if legislation applies, require that the proponent or in some cases the government ministry reviewing the environmental assessment document undertake to provide public notice. In such cases, the notice provides thirty days of lead time before a decision is made on accepting the E.A. with or without a hearing.

Notice formally provides the public with the right to respond to proponent proposals. It is therefore essential that public notification be in such a manner as to notify as many members of the public as can reasonably be expected.

Compliance to legislative or regulatory agency requirements for public notice often places the proponent in a difficult position. For example, legal requirements are for the most part considered inadequate by the public. The inadequate thirty day time period often leaves intervenors in the position of requesting additional time when the application appears before the hearings board, or may result in the proponent being severely criticized for lack of early public involvement by the media. Such actions affect the proponent's ability to complete any approved project within the time schedule desired and translate into financial losses which could have been avoided if proper attention and care to detail had been made.

A prime example of compliance to legal requirements not being sufficient, can be found in Ontario Hydro's Bruce to Milton plans for new high voltage transmission facilities in the mid-seventies. Here the utility complied with all legal requirements, but faced costly construction delays as a result of public opposition along the entire route. In fact, construction was delayed to the point that the utility company was forced to reassess its planning procedures and practices. Unfortunately, damage had been done to the reputation of this Crown Croporation and it still persists.

Problems of inadequate public notice can be addressed by the involvement of the public at the early proposal development stages. In fact, by actively supporting public participation programs well before legal notice is required blunts public and media criticism during later stages of the process, particularly if the proponent uses public participation as a method to determine the form and timing of advanced general public notice. Such practices not only build commitment between the proponent and the public groups involved, but act as a screening mechanism for the proponent.

Access To Information

The problems associated with full disclosure of information also pose difficult hurdles for effective public involvement. Inadequate disclosure, including withholding information vital to the proposal or releasing highly technical and voluminous reports compromise the entire activity.

It is fundamental to the public participation process that studies, background data and reports be available for inspection. It is the proponent's responsibility to ensure such documents are free of technical jargon and are available in such a manner as to expedite public review. By involving the public as early as possible in the planning process, the proponent can avoid the pitfalls associated with complex proposals by permitting careful and informed review over a suitable period of time.

Public Funding

Few issues cause more debate than requests from the public for proponent funding of their review activities. The common view remains that the public acting out of their own self-interest on a volunteer basis should be prepared to accept the cost of public participation in order to influence the decision-making process. Let's examine this view in light of the objectives of public participation.

As volunteers, the public is dependent upon the proponent's goodwill to conduct their review. By restricting support, the proponent can effectively reduce public involvement and yet claim public participation was a major component of their planning process. The predictable result of this scenario is the public continues to criticize the proponent for failing to involve them at an early stage and opposes project plans. Once again, the proponent is vulnerable to such criticism.

A few proponents such as Ontario Hydro have to a limited degree experimented with private funding of Provincial working committees for non-development activities. For the most part, this approach has been positively received by those involved and would, if incorporated into the general public participation program for major projects, produce superior results for the efforts presently being made. It would also answer definitively any criticism of a proponent's commitment to the principles of public participation.

Confidentiality

For the proponent, questions regarding trade secrets, contracts, financial sources are considered to be off-limits in any public participation program. However, from the stand point of public participation, the question is one of necessity. The test should be if the data is absolutely essential to arriving at a particular conclusion or option supported by the proponent, then it should be made available to the public working committees.

The proponent should address the issue early in the public participation process through its working groups or Provincial Committee. A suitable method should be possible on how such information should be released, its format, as well as its detail.

Summary

The issues of notice, confidentiality, access to information and funding must be addressed by the proponent in the early stages of public participation. By employing Provincial as well as local public committees, it is possible for the proponent to identify the issues early in the planning process.

THE ROLE OF PUBLIC PARTICIPATION

Public participation is a mechanism to permit individuals, special interest groups, and the community at large, the opportunity to express their views and influence the decision-making process. Its principles are:

(1) To provide a forum for public interest groups and individuals to consider and comment on the need for the project and options that could address the identified need.

(2) To provide a mechanism for local groups to contribute their own concerns and specific details.

(3) To provide the proponent a forum to present proposals to the general public and the planning process and time frame being considered.

The Royal Commission on Electric Power Planning in Ontario noted, "public participation is a complex issue that requires careful analysis to determine its uses, limits and appropriate forms. In many cases, it also requires a significant change in attitude, an acceptance that valuable contributions can come from the non-expert and a willingness to allow such contributions to form a significant input to the decision process". The Commission also noted and rightly so, that "there is no single, monolithic public interest in our society, and it's therefore wrong to expect any one group to represent the public".

The evolution of public participation programs and techniques continually attempt to address the issues noted by the Commission, mainly the involvement of the widest possible public interest base and the need for the proponent to rely on and incorporate public input into the decision-making process.

Public participation can be categorized into four general types or classes; educational, informational, consultative, and shared or joint planning. Each form has specific limits and depending upon the objectives of the proponent may be selected on that basis.

(a) Educational Approach. Perhaps the most basic approach, educational public participation programs are designed to inform and convince the public of the proponents proposal. The underlying assumption of the approach assumes the public's understanding of the issues and complexities of the proposal is very limited. Activities include holding public information meetings, public speaking engagements and media campaigns. The approach is not intended for incorporation of public input into the decision processes.

This approach is so basic that few, if any, proponents use the approach exclusively.

(b) Informational Approach. The informational or feedback approach represents the first approach to involve the public in decision-making. Under this form the public is asked to comment on planning information, alternatives and proposals. The objective is to gather information and feedback into the decision-making process. In addition to the educational media and public involvement activities, the approach uses field trips and citizen committees as techniques for involvement.

Unfortunately, the public is skeptical of such approaches because crucial areas of the proposals such as need studies are not open for discussion. In addition, the technique fails to incorporate legitimate public comments into the proposals and reduces the activities to a mere public relations function.

(c) Consultative Approach. A more advanced form of public participation addresses the need of the public to play a meaningful role in the decision-making process. Under the consultative approach, the public is encouraged through citizen groups and Provincial working committees to express their local concerns, review study areas, alternatives and proposals. Public comments are documented in the environmental assessment report and are usually noted by the proponent if not incorporated into the proposals. Some areas of concern, namely on questions of project need are not considered and this continues to be a major drawback to this form of public participation.

(d) Joint Or Shared Planning Approach. If the public is to informed on the proposals and is to be encouraged to participate, then it is essential that they feel that their involvement is regarded by the proponent to be essential to the decision-making process. One technique to achieve this objective is for the proponent to make full disclosure of information leading to the developments of their initial proposals. Obviously, such an approach places the public in a decision-making capacity.

By means of small workshops, citizen and Provincial Committees, all issues regarding a specific project are examined including questions on need. By working in close association with the proponent, it is conceivable that a proposal supported by the bulk of participants can be developed and offered for approval. However, co-sponsorship is a very difficult goal.

Provincial Advisory Groups

Provincial interest groups or associations such as the Ontario Federation of Agriculture, play a key role in resolving macro-planning and public participation issues that face a prospective proponent.

These groups, representing many interests and members, can assist the proponent in determining the general planning principles that should be addressed in the proposal, in determining the process for involving the public to best solicit local public involvement and what public participation activities should be undertaken. Additionally, the proponent can involve such groups in assessing their general planning methodology and practices and system principles.

An example of how such involvement can produce benefits to the proponent is again illustrated by Ontario Hydro. In the mid-seventies, Provincial agricultural groups and government ministries were solicited by Ontario Hydro to assist in the development of an environmental methodology for transmission route planning. The formation of an agricultural working group fully supported by Ontario Hydro, produced basic guidelines for the utility in routing and siting generation and transmission facilities. Their first report An Approach To Classifying And Ranking Ontario Foodlands (1976), identified a methodology which could be applied to agricultural lands in order to determine their relative importance. A later report, Provincial Overview of Generation

Siting, The Agricultural Report (1979), addressed the issues associated with siting generation stations in agricultural areas. For example, the effects of emissions on pollutant-sensitive crops and the effect of hydro development on agricultural communities were examined and base maps developed to guide planners. These activities were fully supported by the utility and resources made available to the working groups in order to carry out their objectives. Both reports continue to be used in the planning and review process.

Ontario Hydro also undertook in 1981 a review of their public participation programs by involving Provincial associations and organizations. The findings of the sixty organizations involved representing agriculture, business, environment, municipal government, recreation and resource interests, confirmed that Ontario Hydro's public participation program was not only comprehensive, but clearly the most advanced approach adopted to-date.

Ontario Hydro's attitude to include Provincial advisory groups in the pre-planning stages is essential. It allows the utility to identify issues early and permits their early resolution with public input.

Local Organizations/General Public

Due to the very nature of planning large scale projects, it is impossible for most Provincial associations including O.F.A., to advise the proponent on specifics. On that basis it is essential that the proponent not rely exclusively on Provincial advisory committees, but develop local public participation programs that will solicit local input.

Three major difficulties face the proponent. First, the proponent is likely an unknown commodity; second, any local involvement is usually on a volunteer basis which limits involvement; and third, scheduling requirements may be unrealistic.

The problem of visibility is not new nor is it likely to be resolved without a great deal of effort on the part of prospective proponents. Unfortunately, proponents who rely on Provincial level organizations fail to understand that such organizations rarely can transfer goodwill that may have developed during Provincial reviews. In fact, Provincial associations are limited unusually to making local organizations aware that a project is being proposed, the approvals process to be followed in determining whether the proposal is acceptable, specific information on compensation and construction practices of the proponents and in encouraging their local organizations to be involved.

In achieving local involvement, the proponent usually will rely on small public workshops, citizen committees and public information meetings. Such programs require the proponent to provide resource staff, support materials, and at a minimum, expenses for such items as meeting halls. Again, the key to a successful program at the local level is lead time. It is absolutely essential that the public be provided enough time to review and comment on proposals. The results of such a program should provide beneficial feedback, in fact, an effective local public participation program not only provides the proponent with specific details and local concerns, but if employed properly provides a measure of local acceptability of the proposal before the hearings stage.

Case Illustrations

Throughout this paper, the role of public participation has been highlighted, the problems associated with public involvement as well as the benefits that such an activity can produce. Given that the form of public involvement is left to the discretion of the proponent, it is important to review very briefly the techniques employed.

(A) Ontario Hydro

Operating as the second largest utility in North America and employing over 20,000, the development activities of this utility includes large numbers of class, as well as individual environmental assessment projects. Since 1975, the utility has slowly developed with the assistance of public input, a well formulated public participation plan to address planning issues associated with both types of projects.

One area of excellence has been Ontario Hydro's public participation program directed towards addressing the needs of Provincial organizations. As noted earlier, Provincial agricultural organizations have been involved in advising Ontario Hydro on macro-planning issues.

Ontario Hydro's current program involves two major activities; media and public involvement activities,on an impressive scale. The former activity includes all forms of media to advise local residents that the utility is proposing specific developments in their area. The latter involves the formation of citizen working committees, liaison committees, workshops and Provincial working groups.

Each activity has been developed to make the citizen aware of the proposals, their opportunities to become involved, the need for the projects and as well, the opportunities that exist to discuss options. In effect, the utility has attempted to open up the planning process in order to satisfy the objectives noted earlier for good public participation programs.

The utility's program involves several exceptional aspects, including the staff and financial resources committed to the programs, the lead time provided to conduct program activities, and the multifaceted approach of the program and the extensive involvement of many interested groups. The areas of weakness include the lack of financial support for public participants and local associations in reviewing proposals, the lack of public involvement during the need study stage, the reluctance of the utility to call on or rely on working groups to substantiate their positions during the hearings stage and finally, a general reliance on Provincial associations and organizations to convey to their local organizations the goodwill of the utility rather than develop long-term programs to develop local understanding and familarity.

Overall, the public participation program of Ontario Hydro ranks as well above average.

(B) TransCanada Pipelines Limited

Although a major inter-provincial pipeline company, the development activities of this utility are much less extensive than Ontario Hydro's. For the most part, development consists of line upgrading and looping of existing facilities. As a result, the extent of T.C.P.L. public participation program reflect these conditions.

Recently, T.C.P.L. undertook a major project to supply natural gas to the Montreal area. Existing facilities were judged to be insignificant, necessitating the construction of a major line through agricultural areas. Recognizing the need to involve Provincial as well as local agricultural groups, T.C.P.L. undertook a limited public participation program in order to familiarize affected parties with their proposal and gain their comments.

The program consisted of a series of meetings between T.C.P.L. staff and O.F.A. on the proposals and reasons for the proposed route. In addition, local organizations of O.F.A. in the agricultural regions to be impacted arranged large scale public meetings for the utility and thereby provided a forum for T.C.P.L. to present their proposals and hear the concerns of local residents. The public meetings also facilitated the exchange of information which in some cases lead T.C.P.L. to modify the proposed route in order to avoid prime agricultural land and systematic tile drainage.

T.C.P.L. actively supported local agricultural working committees that reviewed the specifics of the route and their impact. In addition, T.C.P.L. accepted agricultural proposals to retain agricultural drainage experts nominated and/or approved by the local agricultural working committees. Finally, T.C.P.L. developed an effective landowner's guide to inform all affected landowners of the proposal, approvals process, construction practises and compensation policies.

The positive aspects of the program included the reliance on local agricultural organizations to comment on the route, the early contact with Provincial organizations, the professional staff and financial resources provided for public meetings and local committees in their review, and the production of effective printed material to be distributed to all landowners at the time of filing of the application. The problem areas included the narrow scope of the program itself limiting discussion to the proposed route, the inadequate lead time provided to inform the public and conduct independent studies, the lack of financial support for intervenors.

The program initiated by T.C.P.L. relied heavily on Provincial and agricultural organizations to provide a forum for public meetings and although, generally effective, it did lead to charges of inadequate notice by some individuals. The program was considered to be generally effective, given the implied objectives of the utility.

(C) Ontario Ministry Of Transportation And Communications (M.T.C.)

Since the passage of the Environmental Assessment Act in 1975, the Ministry of Transportation and Communications has slowly altered their planning process in order to take into account public concerns. Unfortunately, their program of public participation continues to lag behind the efforts of private and Crown Corporations.

In Ontario, the last decade has seen a marked decline in new highway construction with expansion limited to extending existing highways for the most part. However, the Ministry is heavily involved in highway realignment, and some expansion of existing roads within current right-of-ways. A large percentage of these projects, like in the case of Ontario Hydro and T.C.P.L., occur in rural agricultural settings.

Individual and class environmental assessment procedures adhered to by the ministry require at a minimum, public notice of the proposals planned. As a result the ministry does conduct limited public participation programs.

Unlike Ontario Hydro or TransCanada Pipelines Limited, ministry programs are generally characterized by a lack of O.F.A. provincial level involvement. The relationship has been characterized by a lack of involvement in the preliminary stages, plans for public participation, plans for printed material to be circulated to affected landowners, compensation policies or construction practices. Such areas from a Provincial perspective continue to be very much in-house exercises.

Public participation programs of M.T.C. also rely heavily on the initiative of interested parties to comment on circulated proposals. This approach is again significantly different from the approaches pursued by Ontario Hydro and TransCanada Pipelines Limited. Provision is made for routine public participation activities such as general public meetings and information centres, but special interest groups such as agriculture are generally in the position of having to request special meetings to discuss their concerns. Again, this approach is unlike the other approaches reviewed in this paper.

In our view, current Ministry programs are extremely limited in scope, face severe time restraints, rely too heavily on individual initiatives, lack the necessary involvement of Provincial organizations, and generally convey the attitude that the Ministry views public participation as a secondary or minor activity in the planning process.

In considering the approaches of Ontario Hydro and T.C.P.L., the program is judged to be poor overall.

SUMMARY/RECOMMENDATIONS

In O.F.A.'s view, an effective public participation program achieves the following objectives:

(1) provides a forum to present and discuss information,
(2) enables interested parties to comment on proposals at each stage of the approvals process,
(3) provides the public with an opportunity to consider need, alternatives and options, and
(4) allows interested groups and individuals to contribute a local perspective.

Various approaches and techniques exist to solicit and encourage public involvement during the development, planning and approval stages of the environmental assessment process in order to achieve the noted objectives of such a program. Techniques may include citizen committees, workshops, information centres, and Provincial study committees. However, the failure of current guidelines and legislation to recognize the essential role that public participation can and should play in the decision-making process has resulted in a variety of ad hoc approaches largely dependent upon the proponent. Clearly, Ontario Hydro has developed an impressive public participation program and currently provides the best case example of how effective public programs can influence the decision-making process.

The Following Recommendations Are Offered

1. That Provincial and Federal approaches, whether guidelines or legislation, be amended to require public participation as a mandatory condition for undertaking individual environmental assessment. In the case of Ontario class environmental assessments, it is recommended that an environmental advisory committee be established to review requests to submit proposals for individual environmental assessment. The findings of the advisory committee to be reported to the responsible Minister.

2. That legislation or guidelines be amended to encourage proponents

to financially assist public involvement in the approvals process.

3. That proponents view Provincial advisory committees as an essential component of their public participation program.

4. That proponents include the filing of a minority report in any environmental assessment document.

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ASSESSING SOCIAL IMPACTS IN AN ENERGY-FROM-WASTE PROJECT

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ABSTRACT

This paper describes a survey-based approach that was used to assess the social impacts of an energy-from-waste plant in London, Ontario. It compares the impacts perceived to be most important by local residents with quantitative predictions made by the proponent and identifies existing levels of knowledge and concern about the proposed project. The implications, for the approval process, of a discrepancy between public perceptions and "scientific" predictions are discussed and the usefulness of social survey methods in general is evaluated.

INTRODUCTION

Social impact assessment is a young and rapidly evolving field. One of the neglected tools of social impact assessment is the social survey. For this paper, we discuss the need for social surveys in facility siting and illustrate the usefulness of the survey approach with a case study of an environmental assessment of an Energy-from-waste (EFW) facility in London, Ontario. A questionnaire was distributed to a stratified random sample of 120 households in the immediate area of the proposed facility. The survey generated an enormous amount of information, but we have chosen, in this paper, to examine only selected aspects of the results. Specifically, we investigaged:

(a) descrepancies between the Environmental Assessment (EA) document and the survey results on predicted impacts of the three alternatives;
(b) the level of knowledge about impacts, as reflected in the proportion of residents unable to make predictions about possible impacts; and
(c) the values placed by the local community on a number of environmental and economic concerns.

In all cases, we also test the extent of spatial variation in the responses.

THE NEED FOR SOCIAL SURVEYS IN FACILITY SITING

While most agencies would agree that there is a need for a public participation programme during the siting study and planning phase of a project, few recognize the value of more formal opinion surveys. In fact of the nine projects that have gone before an environmental hearing board in Ontario, none has included the results of a scientifically conducted opinion survey in its submissions.

While there are many reasons why such surveys are not conducted (Jaakson, 1984), it is our belief that they constitute an important supplement to any public participation programme based on public meetings, content analysis of newspapers, or submissions by experts and local interest groups, since they permit valid inferences to be made about the opinion of the whole population. Such surveys or mini-surveys as Finsterbusch (1977) calls them, can be carried out in a cost-effective manner and are particularly useful for generating descriptive information, rough estimations of univariate distributions and some simple two-variable relationships.

Planners and decision-makers are often ambivalent about the perceptions and attitudes revealed by traditional public participation programmes: some pay too much attention to the "activists" in the well-organized and vocal interest groups because of the perceived power that they wield; others discount the opinions of such groups because they reflect the attitudes of small, self-interested segments of society and not those, it is supposed, of the general public (Willeke, 1977).

In our view, any decision based on either type of perception is equally erroneous since, without a survey, it is impossible to know whether, and to what degree, these special interest groups do or do not reflect the opinions of the "silent majority".

A properly conducted random-sample survey can provide the following types of information:

1) the existing levels of knowledge about a proposed project and its alternatives;
2) the nature and magnitude of the perceived impacts of the alternatives, both positive and negative;
3) the relative importance attached by the community to each component of the impacted environment, and
4) the degree of apathy, opposition or support for each of the alternatives.

Existing Levels of Knowledge

Unless the public has basic information about the proposed project and its alternatives, it is impossible for its members to make informed judgements about possible impacts and what their effect will be. Lack of such information will often result in groundless fears and, as our study shows, opposition to all alternatives.

A survey will reveal both the type and the spatial distribution within the community of deficient knowledge and suggest appropriate efforts that can be made to remedy the situation. If it is a large community, the location of the most uninformed public will be known and these areas can be specially "targetted".

The Nature and Magnitude of the Perceived Impacts

Even where there is a basic knowledge about the project being proposed, there may still be fears expressed about the impacts that are real, groundless, or appear groundless to the proponent. Where the fears are justified, the survey will provide the proponent and regulatory agency with better information as to where the fears are most strongly felt and appropriate mitigation measures can be proposed to allay them. Where the concerns are groundless, or appear to be groundless, correct information about the predicted impacts and the probability of their occurrence can be supplied, especially to those locations where there are the highest levels of unjustified concerns. It may also happen that the survey will reveal to the proponent and regulatory agencies concerns about project impacts that the latter were unaware of and which can then be addressed.

The Relative Importance of Environmental Components

If a properly conducted EIA is being carried out, the proponents and the regulatory agency should want information not only about the actual and perceived impacts, both positive and negative, but also the importance that different publics attach to the various components of the environment impacted. The "weights" obtained from the publics and from the various agencies concerned could then be used, together with the magnitude of impacts, to arrive at the "best" alternative.

This type of information is most useful to have, because many studies have shown (Whyte, 1977) that there are significant differences of opinion among experts and publics about the importance of different components of the environment. Serious planning errors can arise, and powerful opposition can be generated when the hierarchy of concerns about components of local environments is perceived differently by experts and public. For example, a great deal of effort may be devoted to reducing noise levels when the real concern is about traffic safety.

The Degree of Support for the Project

A survey provides objective information about the levels of opposition, apathy or support for a project which cannot be obtained through the normal public participation channels; it will indicate to what degree those levels are common to both the activist public and the silent majority and to what degree they differ. Hence, it will also indicate whether vocal groups are really voicing widely held concerns or just promoting their own limited interests.

It is very important that proponents and regulatory agencies are aware of the concerns of the silent majority during the hearing and planning phases of a project. A carefully designed survey can distinguish among the various sub-groups of the "silent majority". There are those who are concerned about the general environmental and social issues, but who, have not made their voice heard. Another sub-group belongs to the "not-in my-backyard" category. Their concerns are site specific and evaporate if another location is proposed. A third sub-group are the apathetic - who neither know nor care to know, about the issues involved.

A knowledge of both the size and the spatial distribution of each of these sub-groups is useful in a number of ways. Once the distribution of the concerned but "non-activist" components of the public have been identified, they can be encouraged to contribute to the decision-making process through specailly designed programmes. It may also be useful to know the location of the "apathetic" sub-group, particularly in cases where several candidate sites have been selected, so that those with the lowest "opposition", or most apathy, can be identified (Sherman, 1978).

It is important that these sub-groups of the silent majority be determined by surveys at an early stage of project design and site selection to avoid serious opposition and greater delays at some later stage.

A classical exmaple of the failure to do this has been the recent courtcase to overturn a hearing board selection of a specific hydro corridor because it had neglected to make provision for opposition to that route being voiced (Toronto Globe and Mail, 1984).

In addition to the benefits described above, surveys have an important legitimizing function in the public participation process. Opinion surveys are now accepted by the public as a legitimate basis for decisions, ranging from product marketing strategies to the formulation of complex governmental policies. Thus, if a survey is added to the other public participation programmes in the environmental assessment process, it will not only provide additional information, but will serve to legitimize the process as a whole. To achieve this legitimacy, of course, it is desirable that such surveys be carried out by an organization that is independent of the proponent.

THE CASE STUDY

A Brief History

In 1982 Victoria Hospital submitted an Environmental Assessment document (Victoria Hospital Corporation, 1982) to the Ontario Ministry of Environment for a proposed EFW facility on the Hospital's Westminster Campus in London, Ontario.

Victoria Hospital is presently served by an outdated energy plant which draws electricity from the public utility and generates heat from natural gas. The electrical installation needs to be upgraded and the boilers replaced in order to maintain present service and supply energy to planned future developments.

The facilities of the Hospital lie on 325 acres of land in south London. A 250-bed psychiatric hospital already exists on the site and two additional buildings, a 340-bed general hospital and a 450-bed chronic care hospital are now under construction. An extensive portion of the south and east sections of the property remains undeveloped. This area is heavily wooded and contains three small bodies of water known as Westminster Ponds. The proposed location for the EFW plant is in the north east corner of the property on abandoned agricultural land. This site is roughly in the centre of a large area of residential land use, that lies within 400 to 2500 metres of the proposed plant.

The feasibility study for an EFW facility, using either solid waste or solid waste and sewage sludge, was conducted by the Hospital in 1980 and 1981 (ECE Group, 1981). The Hospital presented the results of this study at public meetings held in the spring and summer of 1981. In November, 1981, a number of ratepayers' groups joined together to form the Citizen's Coalition to Maintain the Environment. As a result of the public meetings and communications between the Hospital and the Coalition, the City of London, and the Ontario Ministry of Environment , the Hospital decided to ask the Ministry of Environment to make the proposed plant subject to the Ontario Environmental Assessment Act. Since the Hospital is privately rather than publicly owned, it would not have been subject to the Act unless it specifically requested that it be so applied. Victoria Hospital was the first private environmental assessment in the history of the Ontario Environmental Assessment Act, the first assessment of an EFW facility, and only the second assessment to be heard by a Joint Board under the 1981 Consolidated Hearings Act. Thus, in many ways, it was a landmark case for environmental assessment in Ontario.

The Hospital held an additional public meeting in February 1982, and then filed its Environmental Assessment document in July, 1982. The Hospital was given the opportunity to reply to the Ministry's review of the EA document before it was submitted to the Environmental Assessment Board (ECE Group, 1982). The Environmental hearings began in February and concluded in June 1983.

The following alternatives evaluated in the EA document were considered at the hearing:

A. Conventional Plant. This plant would use electricity from the municipal public utility and generate steam from natural gas with a fuel oil standby.

B. Energy from Waste Plant (Solid Waste). This plant would generate steam by incinerating municipal solid waste and would co-generate electricity. The plant would be equipped with a backup fossil fuel boiler plant and would process 300 tons of garbage per day. Burning solid waste at the plant will extend the lifetime of the City of London's landfill site by four years.

C. Energy from Waste Plant (Solid Waste and Sewage Sludge). This plant would be similar to the EFW Solid Waste plant, but it would also extract energy from incineration of sewage sludge cake. The partially dried sludge would be transported by truck to the EFW plant from the Greenway waste management facility three and a half miles away. The Ministry of Environment has issued a control order for the replacement of the sewage sludge incineration unit at Greenway. The EFW Solid Waste/Sewage Sludge plant will remove the need for the City of London to construct a new incinerator at Greenway.

There were five parties represented at the hearings. The Hospital, the City of London, and the Ontario Ministry of Energy all supported an EFW facility with solid waste and sewage sludge. The Ministry of Environment also supported the Solid Waste/Sewage Sludge facility, but expressed concern about a number of environmental factors. Their primary concern was that they were not convinced that the plant would meet all of the criteria, standards, guidelines and provisional guidelines for air emissions.

The Citizen's Coalition neither opposed nor favoured any of the alternatives. They felt that their primary role was to ensure that a thorough critique of all the alternatives was presented to the Board and that neighbourhood interests were protected. Since the proponent, namely the Hospital, favoured either type of EFW facility over a conventional plant, these facilities were the main focus of the Coalition's criticism. The coalition felt that the EA document had not addressed the following concerns adequately (Citizen's Coalition for a Safe Environment, 1982).

(a) noise levels
(b) traffic flows
(c) property values
(d) economic feasibility
(e) ownership of the plant
(f) dioxin and furon emissions
(g) other pollutants, such as NO_{x1}, SO_2
(h) ecological sensitivity of the Westminster ponds area.

(i) effect on plants and animals
(j) health effects
(k) use of an unproven technology for the EFW plant
(l) odours

After 50 days of hearings, the Environmental Assessment Board decided to accept the EA document; subject to 17 conditions (Joint Consolidated Hearings Board, 1983). Ten of these conditions were related to air quality controls and monitoring, the remainder were related to ownership, complaint and performance review procedures, pathological wastes, and odour controls.

Structure of the Survey

The survey was conducted by students from the University of Toronto as part of a joint graduate/undergraduate course in environmental impact assessment and distributed in March, 1983, during the Environmental Assessment Board Hearings. There were 24 questions in the questionnaire, covering six main topics: (a) respondent's perceptions about predicted impacts of the three alternatives on different aspects of the environment; (b) value placed by the respondent on a number of economic and environmental costs and benefits likely to be generated by the project; (c) extent and type of public participation to date; (d) a direct question about which alternative the respondent preferred; (e) plant management; (f) location of the respondent's place of residence in the survey area.

The questions were prepared in consultation with the Citizen's Coalition and the Ontario Ministry of Environment. The format of the questionnaire was pretested on students at the University of Toronto.

The first set of questions on predicted impacts asked the respondents to indicate the degree of impact they felt each of the three alternatives might have in their neighbourhood on, among others: air pollution, odours, water pollution in Westminister Ponds, loose litter, destruction of plants and animals, cost of London's waste management programme, dust and ash problems, local tax rate, and property values. The degree of impact was measured on a seven point scale, ranging from "large increase" to "no change" to "large decrease". The questions also included a "don't know" category.

The second set of questions asked respondents to allocate an amount of money, from $0 to $100, to each of 12 environmental and economic criteria according to their desire to see a reduction in the relative levels of those criteria. An allocation of $100 to any criterion indicated the highest level of concern possible for that criteron and an allocation of $1 is the lowest level possible.

Further details on the two sets of questions described above, and the remaining questions is provided by a copy of selected questions from the questionnaire in the Appendix.

The sample taken was a stratified random sample of 120 household in the target area indicated by figure 1. Approximately equal proportions of households were drawn from each neighbourhood surrounding the proposed plant. Five groups of two people each distributed the questionnaire during a two-hour period on a weekday morning and collected them that evening. If the questionnaire had not been completed by that time, the householder was asked to return it as soon as possible in a stamped, pre-addressed envelope. Before receiving the questionnaire, the household was asked whether he or she had heard of the EFW project. If the householder had not heard of the project, then the household was excluded from the survey. Sixty-three questionnaires were returned altogether, of which about 10% were mail-backs.

Survey Results

Prediction Discrepancies Between the EA Document and the Survey Results.

In this section, we examine the predicted impact discrepancies found between the Hospital's EA document and the survey results for 10 environmental and economic criteria. As noted in the previous sections, the existence of prediction discrepances can have important implications for the proponent. Tables 1 to 3 describe the discrepancies for each of the three alternatives. We have chosen the median response category for each question as a summary measure of the local community's views, and have attempted to place the Hospital's EA impact predictions for each of the alternatives onto the same scale. In most cases, applying the seven-point scale to the Hospital predictions was fairly straight forward, but, in two cases, more than one interpretation of the appropriate category assignment was possible.

The Hospital's predictions for traffic flow impacts were a 26% increase in truck flows for the solid waste EFW facility and a 30% increase for the solid waste/sewage sludge EFW facility. We consider both of these to be "moderate" increases. Interpreting the air pollution impact was more difficult. In comparing the two EFW facilities to the conventional plant, the Hospital EA predicted that maximum ground level concentrations of NO_2 would be 10 and 11 times higher than a conventional plant, for the solid waste and solid waste/sewage sludge facility, respectively; 12 and 13 times higher for ACl; and 9 times higher for SO_2 at both facilities. None of the concentrations will exceed provincial standards. We therefore consider increases in air pollution levels attributable to both facilities to be "moderate" increases.

It is immediately apparent from Table 1 that there are few prediction discrepancies between the Hospital and the survey about impacts from the conventional plant. The median response in the survey was one category higher than the Hospital's prediction only for air pollution and local tax rates. Table 2 displays a wider range of discrepancies. The median response in the survey is one category higher than the Hospital's for waste management

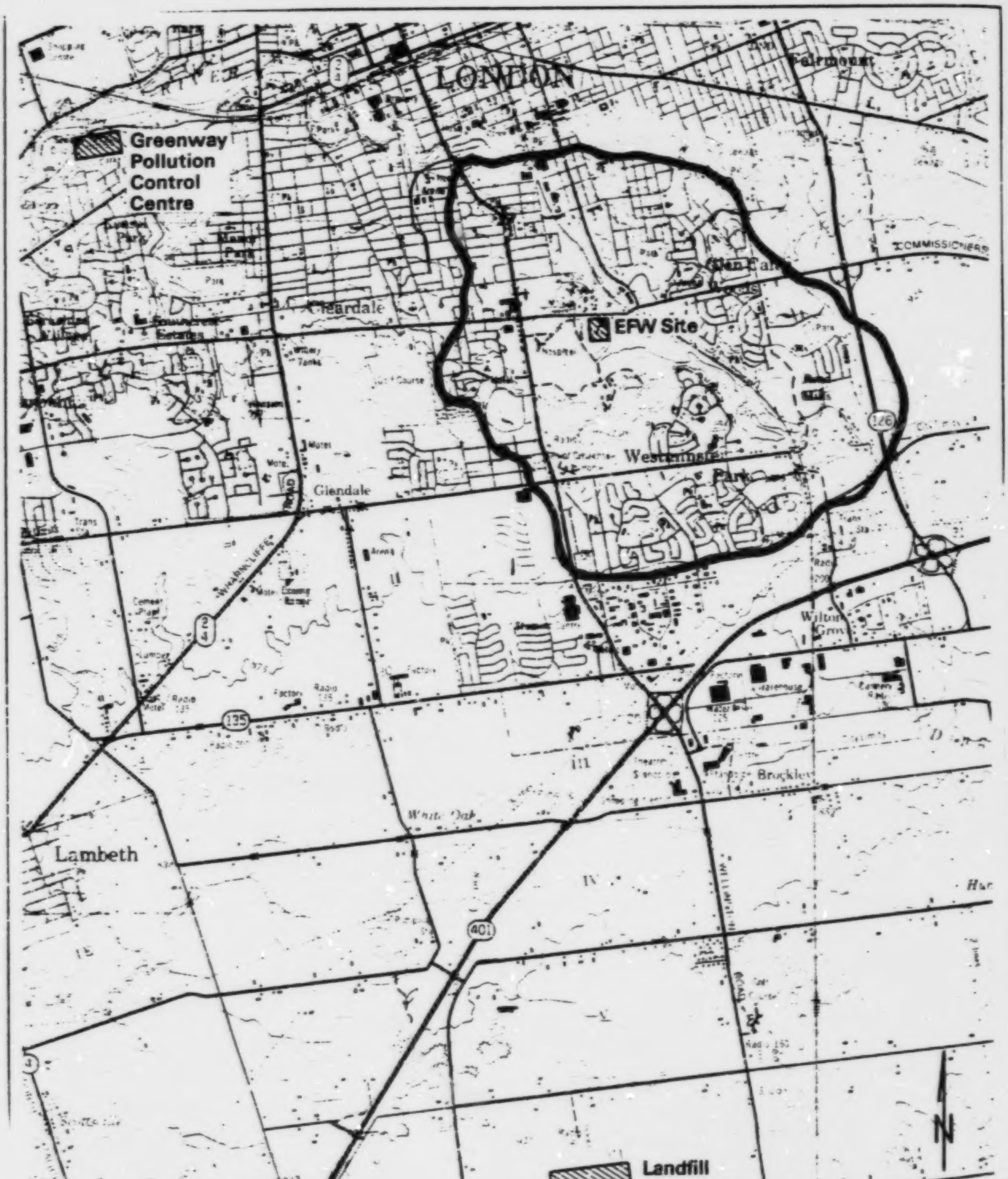
LONDON
Fairmount
Greenway
Pollution
Control
Centre
COMMISSIONERS
Glen Cairn
Cleardale
▨ EFW Site
Golf Course
126
Westminster
Park
Glendale
WHARNCLIFFE ROAD
24
135
Wilton
Grove
Brockley
White Oak
Lambeth
401
4
Landfill
Site W12A
N
0
1
2 Miles
0
1
2
3 Kilometres

Figure 1: Victoria Hospital energy-from-waste site and sample-survey area.

Table 1* Comparison of Survey Responses and Hospital Predictions for Conventional Plant Impacts

	Large Increase	Moderate Increase	Slight Increase	No Change	Slight Decrease	Moderate Decrease	Large Decrease	Don't Know†
(a) waste management costs				S/H				35%
(b) traffic volume				S/H				24%
(c) property values				S/H				21%
(d) pollution in ponds				S/H				44%
(e) loose litter				S/H				46%
(f) odours				S/H				44%
(g) air pollution			S	H				17%
(h) dust and ash				S/H				21%
(i) tax rate			S	H				30%
(j) plants and animals				S/H				24%

* S = median response category in Survey
H = Hospital's predictions

† % of survey respondents answering 'don't know' to that question

Table 2 Comparison of Survey Responses and Hospital Predictions for Solid Waste Plant Impacts

		Large Increase	Moderate Increase	Slight Increase	No Change	Slight Decrease	Moderate Decrease	Large Decrease	Don't Know†
(a)	waste management costs			S	H				32%
(b)	traffic volume		S/H						20%
(c)	property values				H	S			22%
(d)	pollution in ponds			S	H				46%
(e)	loose litter				S/H				43%
(f)	odours		S		H				40%
(g)	air pollution		S/H						22%
(h)	dust and ash		S		H				21%
(i)	tax rate			S	H				32%
(j)	plants and animals			S	H				22%

Table 3

Comparison of Survey Responses and Hospital Predictions for Solid Waste/Sewage Sludge Plant Impacts

	Large Increase	Moderate Increase	Slight Increase	No Change	Slight Decrease	Moderate Decrease	Large Decrease	Don't Know
(a) waste management costs			S	H				32%
(b) traffic volume		S/H						20%
(c) property values				H		S		22%
(d) pollution in ponds		S		H				46%
(e) loose litter				S/H				46%
(f) odours	S			H				40%
(g) air pollution	S	H						19%
(h) dust and ash		S		H				20%
(i) tax rate			S	H				32%
(j) plants and animals			S	H				21%

costs, property values, pollution in Westminster Ponds, local tax rate, and destruction of plants and animals. There is a more serious discrepancy for odours and dust and ash problems, where the survey median response is two categories higher than the Hospital's prediction.

As indicated by Table 3, the solid waste/sewage sludge EFW facility generates the most and largest prediction discrepancies of the three alternatives. The median response in the survey is one category higher than the Hospital's predictions for waste management costs, local tax rate, destruction of plants and animals, and air pollution. It is two categories higher for property values, pollution in Westminster Ponds, and dust and ash problems, and three categories higher for odours. Obviously, the community's fear about an increase in odours from the solid waste/sewage sludge facility is the most important impact that the Hospital should address when attempting to reconcile the above discrepancies. These is a distinct trend in the severity of the prediction discrepancies from slight to most severe as the technology of the proposed plant moves along the scale of conventional to innovative. This is not surprising, given that less is generally known by the public and, frequently by the proponent, about innovative technologies than conventional ones.

None of the discrepancies discussed above displayed any spatial variation. A Kolmogrov-Smirnov test of the North and West areas of the sample against the South and East areas found that there were no significant differences ($\alpha = .05$) in response distributions to each question between the two area.

The "Don't Know" Category. In order to evaluate a respondent's perceived level of knowledge about predicted impacts, each respondent was assigned a score from zeroto 36, reflecting the number of times he or she had responded "don't know" to the 36 questions on predicted impacts of the three alternatives. Fifteen respondents, or 24% of the samples received a score of zero, indicating that they never responded in the "don't know" category for a question. Seven respondents or 11% of the sample, received a score of 36, meaning that they answered "don't know" to every single question. Just over 3/4 of the respondents were uncertain about the potential impacts of one or more alternatives on one or more aspects of the environment.

Table 1 to 3 also present the response distribution of "don't knows" for each of the impact questions about the three alternatives. A Cochran Q test ($\alpha = .05$) indicated that the proportion of those replying "don't know" to each question did not vary significantly across the three alternatives. In other words, if a respondent did not know what the potential impact of one alternative would be, then it was unlikely that he or she would be knowledgeable about that particular impact for any other alternative. This suggests that attempts to increase the level of knowledge about potential impacts in the community should focus on all alternatives, not just one or two.

Finally, Table 4 describes the distribution of responses to a question that asked respondents to indicate whether they favoured one or more of the three alternatives. Three missing responses are not included in the table. The table also presents the average level of knowledge about impacts for those favouring one of the three alternatives or no alternative at all. An analysis of variance ($\alpha = 0.05$) indicated that those opposed to all of the alternatives (i.e. those choosing the 'none' category) had a significantly lower average level of knowledge about impacts than those favouring one of the alternatives. Additionally, there was no significant difference in average level of knowledge among those favouring one of the three alternatives. The implications of this result are that increasing community knowledge about the types of potential environmental impacts of the alternatives through, for example, information programmes, will tend to increase the number of people favouring at least one of the three alternatives. The analysis does not lead to predictions about which alternatives will receive more support but does suggest that high knowledge levels will reduce negative attitudes towards the construction of any plant on the site.

	Conventional	Solid waste	Sewage sludge	None
Number of respondents	30	9	15	6
Average knowledge score *	10.7	13.7	10.3	24.7

Table 4: Average level of knowledge of respondents favouring one or more of the alternatives.

Valuation of Criteria. Table 5 presents summary data on responses to questions about valuation of environmental and economic concerns. The table is broken down into eight categories, according to direction of the Hospital from the respondent's place of residence. Recall that larger dollar values allocated to any criterion indicate greater concern about that criterion. Respondents value air pollution more than any other criterion and value development costs for the hospital least. Respondents in the South and East quadrants of the sample (identified in table 5 as 'North", 'Northwest' and 'West') generally valued all criteria at a higher level than did other respondents. However, a one-way analysis of variance performed on all of the Criteria indicated that only the valuation of air pollution was significantly ($\alpha = .05$) higher in the South East quadrants.

* Note that higher scores indicate increasing lack of knowledge.

Concern	North (m=10)	Northwest (m=4)	West (m=3)	Southwest (m=1)	South (m=11)	Southeast (m-9)	East (m=8)	Northeast (m-8)	Question Average (m=54)
	Direction of the Hospital from Respondent's Place of Residence								
Air pollution	85.4	96.3	100.0	100.0	77.7	67.1	55.6	86.5	78.1
Odours	78.8	85.0	93.3	80.0	78.2	51.0	78.6	61.4	72.8
Plants and Animals	80.5	70.0	91.7	90.0	68.6	59.4	65.6	63.6	70.0
Ponds	81.5	61.3	90.0	90.0	65.0	54.4	66.8	63.1	67.9
Dust and Ash	73.3	88.6	73.3	90.0	75.5	59.9	46.9	70.8	68.5
Property values	67.2	43.8	70.0	99.0	59.6	51.1	50.5	49.3	56.8
Litter	64.3	72.5	63.3	90.0	63.1	32.7	53.1	51.4	56.2
Noise levels	65.2	37.5	53.3	90.0	60.9	44.5	45.0	52.1	53.7
Energy Efficiency	68.0	44.0	75.0	90.0	29.1	51.2	43.1	56.9	50.5
Traffic Flows	42.3	55.0	63.3	90.0	46.8	46.7	48.3	25.1	45.7
City Costs	44.4	32.5	62.5	0.0	21.4	28.3	39.4	43.8	34.8
Hospital Costs	35.1	28.7	12.5	0.0	24.1	23.2	33.7	15.7	25.7
Direction Average	65.5	59.6	70.7	75.8	55.8	47.5	52.2	52.0	

Table 5: Average Dollar Value Assigned by Respondents to Different Concerns.

CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

Surveys can be a valuable tool in the assessment of the social impacts of a project. They can be used to discover the views of the "silent majority" and determine whether those views differ significantly from those of the "activists" and the proponent. The Victoria Hospital case study provided several examples of discrepancies in impact predictions between those made by the proponent and those perceived by the local community. It also revealed that level of knowledge about impacts had a significant effect on an individual's decision to favour one of the given alternatives.

Finally, the case demonstrated how surveys can be useful in evaluating a community's environmental concerns.

For large and controversial projects, where the hearing process extends over a long period of time and where opinions, attitudes, and concerns may change, future research is required in the use of continuous opinion monitoring systems. For example, a sub-sample of the various groups already identified in a preliminary survey could be retained during the hearing, planning, construction and operation phases to monitor the community's changing concerns about the project. This will allow proponents and regulatory agencies to make appropriate respones at an early stage before widespread opposition develops.

Additional research is required into the timing of surveys; the role of surveys in providing as well as gathering information about projects (Jaakson, 1984) and the design of survey instruments and techniques to elucidate the most pertinent information on the magnitude and the importance of the perceived impacts.

Research must also be conducted on how to make the most effective use of information gathered in surveys in the hearing and decision-making process.

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APPENDIX

EFW Questionnaire

The following three alternatives are being considered to supply energy for Victoria Hospital:

Alternative A: Conventional energy plant using natural gas oil and electricity;

Alternative B: An energy-from-waste plant using municipal solid waste.

Alternative C: An energy-from-waste plant using municipal waste and sewage sludge.

1. We would like to know what you think will be the positive and/or negative effects of each of the above alternatives. Please check the appropriate boxes and add any comments in the spaces provided below for each alternative A, B, and C.

(a) Change in the cost of London's waste management programme

	large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't Know
A. conventional								
B. solid waste								
C. solid/sludge								

(b) Change in traffic volume in your neighbourhood

	large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't know
A. conventional								
B. solid waste								
C. solid/sludge								

(c) Change in property values in your neighbourhood

	large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't know
A. conventional								
B. solid waste								
C. solid/sludge								

(d) Pollution in ponds near the hospital site

	large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't know
A. conventional								
B. solid waste								
C. solid/sludge								

(e) Loose litter in your neighbourhood

	large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't know
A. conventional								
B. solid waste								
C. solid/sludge								

(f) Odours in your neighbourhood

	Large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't know
A. conventional								
B. solid waste								
C. solid/sludge								

(g) Change in air pollution in your neighbourhood

	large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't know
A. conventional								
B. solid waste								
C. solid/sludge								

(h) Dust and ash in your neighbourhood

	large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't know
A. conventional								
B. solid waste								
C. solid/sludge								

(i) Effect on your local tax rate

	large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't know
A. conventional								
B. solid waste								
C. solid/sludge								

(j) Destruction of plants and animals

	large increase	moderate increase	slight increase	no change	slight decrease	moderate decrease	large decrease	don't know
A. conventional								
B. solid waste								
C. solid/sludge								

2. How far do you live from the hospital? (walking distance)

____ less than 5 minutes

____ 5-10 minutes

____ more than 10 minutes

3. Please indicate the direction of the hospital from your home.

____ North

____ North-east

____ North-west

____ East

____ South

____ South-east

____ South-west

____ West

4. (a) Which of the three projects would you favour?

____ conventional

____ solid waste

____ solid waste/sewage sludge

____ None.

(b) If NONE, could you suggest any other alternative that you would favour?

____

____

5. (a) Have you expressed your opinion publicly about any of the proposed projects?

____ yes

____ no

(b) If YES, how was this done? (letter to newspaper, attendance at meetings, etc.)

____

____

6. We would now like to ask you some questions about your attitude towards different aspects of possible energy supply schemes. Suppose that the Ontario Government is prepared to give you money to help promote those aspects of the Victoria Hospital energy scheme that are of greatest concern to you. Please study the list of concerns below and decide how much money you would request from the government to support each of the alternative schemes. This should be applied to the alternative that is of greatest concern to you. You would request $0 for the scheme(s) that you have no interest or concern about. Amounts ranging from $1 to $100 should be requested for all other schemes below according to your degree of concern about them.

		$
(a)	The scheme that will have the least negative effect on local ponds and streams.	______
(b)	The scheme that will have least negative effect on property values.	______
(c)	The scheme that will have most effect on reducing odours.	______
(d)	The scheme that will cost the least to the hospital.	______
(e)	The scheme that will lower the costs to the City of London for solid waste	______
(f)	The scheme that will be most energy efficient	______
(g)	The scheme that will cause least litter	______
(h)	The scheme that will result in the least increase in noise levels.	______
(i)	The scheme that will result in the least increase of air pollution	______
(j)	The scheme that will most reduce dust and ash problems.	______
(k)	The scheme that will result in the least increase of traffic volume	______
(l)	The scheme that will cause the least destruction to plants and animals.	______

A PUBLIC INVOLVEMENT STRATEGY FOR SITING TRANSMISSION LINES: TWO CASE STUDIES

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ABSTRACT

This paper outlines two case studies of public involvement strategies for major transmission lines. It reviews the procedures and techniques used by the Bonneville Power Administration to involve the public in the decisionmaking process and how they were accepted. The experiences on these projects have contributed significantly to overall public involvement planning and have resulted in practical ideas and steps for a successful public involvement program.

Since the enactment of the United States National Environmental Policy Act (NEPA) in 1970, and the U.S. Council on Environmental Quality (CEQ) Regulations in 1979, Bonneville Power Administration (BPA) and other Federal agencies have tried different ways to involve the public in the decisionmaking process for large Federal projects. The process outlined by this act calls for Federal agencies to gather potential issues and concerns of the public, focus on these issues in their environmental analysis, and make decisions based as much on environmental factors as on economic and technical criteria. This paper looks at two of BPA's large transmission projects required by law to meet the spirit and intent of NEPA. It reviews the processes used by BPA for citizen participation, the successful techniques used and a new strategy for future projects.

THE GARRISON-SPOKANE TRANSMISSION PROJECT CASE STUDY

In 1977, Bonneville Power Administration proposed building a 500-kv transmission line from western Montana to Spokane, Washington. The Federal agencies responsible for writing the Environmental Impact Statement for the transmission line decided to jointly evaluate key Federal decisions on a corridor for the line. Because of Federal agencies' NEPA requirements, the public would participate in the analysis and also the decisionmaking process.

As the Federal team began the process of studying and managing this new transmission line section, strategies for involving the public were incorporated into the work plan for the project. Objectives outlined for the public involvement process were:

1. To inform
2. To invite participation
3. To provide convenient opportunities for people to be involved early and often [1]

To meet these objectives, general responsibilities of each agency for different components of the public involvement plan were assigned. To begin the process, meetings were set up with local land use planners and officials for an information exchange. Methods for informing the public were developed and included an issue newsletter; establishing a local office in Missoula, Montana, to better serve local people and groups by giving them one key contact point; identifying objectives and expected results of public involvement for each phase of the project; using local media; and holding scoping meetings to identify important topics for consideration. An extensive mailing list was also started of individuals and groups that might want information about the project, and for sending out summaries of the scoping meetings to participants. In addition to scoping meetings, informal meetings were planned as needed, and included open houses and workshops. Time periods were set aside during the process to solve common concerns through different project coordinators of Federal and other agencies. A content analysis was completed to provide an objective survey of public comment and this summary of public concerns was used for making decisions.

To begin the scoping process for the line, meetings were held to define issues and concerns and to seek comments on centerline location. These meetings were designed to be informal and participatory, with individuals looking over resource maps. Because this project was controversial, most meetings were lively with much discussion. The format of being able to work one-on-one with people created a receptive atmosphere at most of the meetings. The results of these meetings and an updated schedule were sent to participants in a mailer after the meetings.

As environmental studies continued, workshops were held throughout the study area to meet the objectives specifically designed for this phase:

1. Seek review of issues, alternative plans of service, and routes.

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[1] Garrison-Spokane 500-kV Transmission Project, Plan for Environmental Studies, Bonneville Power Administration, November 1979, amended June 1981.

2. Identify evaluation criteria.

3. Use public participation to verify or revise the important topics and evaluation criteria and refine routes. 1/

Following the workshops, newsletters were sent to the participants.

As the environmental documents were completed and possible routes were refined, news releases, newsletters, a special phone number for comments, and additional one-on-one and larger meetings were used to keep the public informed and able to comment on the process. Although public input was used in all decisions, there were inevitably some areas of unresovled conflict with landowners and some interest groups unhappy with routing choices.

To defuse this conflict, smaller meetings were held one-on-one with individuals and groups. A facilitator with expertise in conflict resolution was hired by BPA to work out compromises on site specific questions with some groups. This happened in the Maxville, Montana, area of the project. The facilitator was able to work with the people of the Maxville area in formulating an alternative route. A variation of this alternative was ultimately implemented by BPA.

As a result of the public involvement efforts on this project, several things happened. A list of issues was developed for concentrating environmental studies. From comments received, evaluation criteria for ranking route alternatives were evolved. New alternatives were proposed by the public and then evaluated by BPA. Some of BPA's proposed routes were eliminated because of public concerns. In addition, route changes, special designs for structures, and other mitigation measures were incorporated into the final project.

THE BOUNDARY-SPOKANE/COLVILLE VALLEY SUPPORT PROJECT CASE STUDY

This project, located in northeastern Washington state, consists of replacing an existing 100-mile BPA 115-kv line from just north of Spokane to the U.S.-Canadian border with a new double-circuit 230-kv line. The line would, for the most part, be on existing right-of-way. The line is needed to reinforce the electric power system in the Colville Valley area and to provide additional capacity for 40 MW of new generation at Boundary Dam and a new wood residue generation plant at Kettle Falls, Washington.

1/ Garrison-Spokane 500-kV Transmission Project, Plan for Environmental Studies, Bonneville Power Administration, November 1979, amended June 1981.

This project, because it is mainly a rebuild, was not thought to be controversial. However, a public involvement plan was developed to provide for public participation.

The public involvement plan developed for this project was similar in many ways to the one prepared for the Colstrip project. It was designed by two key project team members, the environmental coordinator for the project and the local Area Engineer, and was reviewed by other interested members of the BPA organization. The plan stated the objectives for public involvement, and stressed BPA's commitment to encouraging participation by different publics. It also emphasized BPA's commitment to making a decision that took into account the comments of the public. The objectives were:

1. To inform the public, including affected landowners, utilities, and Federal, state, and local agencies of BPA's proposed project and its status.

2. To invite the public, affected landowners, utilities, and cooperating agencies to participate in the environmental and decisionmaking processes of the project.

3. To provide the public with opportunities to identify alternatives, resources, and issues of concern to the project.

4. To gather information from cooperating agencies and others for use in the analysis process.

5. To provide the public, affected landowners, utilities and agencies with opportunities to review and comment on the project environmental analysis.

6. To make a decision on the project which reflects the input of all interested public and cooperating agencies. 1/

The public involvement plan also outlined lead organizational responsibilities for the program as well as public involvement tasks to be completed over the life of the project, including the land acquisition and construction phases.

The atmosphere to be created on this project was one of informality and consistency. The project area is mostly rural or rural residential.

1/ January 19, 1984 Bonneville Power Administration Memorandum, from Timothy J. Murray (EVH), to Paul E. Eichin (OKE), Subject: Boundary-Spokane/Colville Valley Support Project--Public Involement Plan.

The main industries are farming, mining, and logging, with some tourist trade. Too often in the past, BPA has been thought of as a large, impersonal institution. Consequently, the intent of the plan was to try to change that image by doing things informally. In a large organization, with responsibility for public contact spread out across many parts of the agency, it is often very hard to coordinate contacts with individuals. This had come up on past projects--that is, people complained about having to deal with a different person every time they talked to someone or received material from BPA. To change this, all material sent out to the public was to have the same person's name on it. Meetings or workshops were designed to be informal, but controlled enough to allow everyone an opportunity to speak.

Briefing sessions were scheduled with agencies and local officials before anything was sent to the public. These allowed the team to get an idea of who would be interested in the project, and to identify local interest groups and the concerns they might have, before any public meetings were held. The sessions also assured that local politicians were aware of the project before their constituents called them for action or opinions; it was hoped that the politicians and their publics would both look more favorably on BPA as a result.

Generally, the initial scoping meetings were successful. The format of each meeting included a brief description of the project (15 minutes), followed by a listing from the audience of issues and concerns, and then by a period of questions and answers. This format was adhered to and no one disrupted the meetings or took over control. About 50 people attended the Colville meeting. At first, the reaction of the public was negative. However, by allowing their concerns to be voiced and noted, and by answering questions when possible, this negative feeling was turned around. One individual said, "I came here kind of negative tonight, but right now I feel a little more positive about this. I see a need for the increased size of the lines." 1/

At the meeting in Metaline Falls, one woman brought a prepared statement on electical effects and asked permission to deliver it. She was given the opportunity. Afterwards, she continued talking until both the audience and the BPA personnel were anxious for someone else to take the floor. Allowing her to voice her concerns enhanced BPA's credibility, but did not appear to persuade any other people to her position.

Some months later, after a summary of issues and concerns was sent to scoping meeting participants and the environmental work was almost complete, open houses were held. These were designed to give people a

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1/ Bonneville Power Administration, Transcript of Proceedings, Re: Public Meeting on Proposed Colville Valley Support Transmission Line Rebuild Project.

chance to review the environmental work done to date, to check it for accuracy, and to ask more questions about the project. The open houses were held in the afternoon and evening with no formal presentation. They were attended by environmental specialists, a location engineer, and an engineer representing the local BPA office. This allowed BPA staff to discuss issues one-on-one with people and begin the development of mitigation measures with landowners. The open houses were not designed to be stages for open confrontation. The key was to establish a nonthreatening environment, especially for individuals who might be afraid to speak in a large group. Attendance at the open houses was small compared to the scoping meetings.

In addition to the open houses and briefings with local government officials, there were many one-on-one contacts with individual landowners. Although no formal newsletter was developed for the project, periodic letters kept individuals informed about the project's status. This may be the reason for the low attendance at the open house sessions.

ISSUES IDENTIFIED

From the experience on these two projects, and from the many transmission projects that BPA has been involved in since NEPA, certain patterns and issues have emerged. An understanding of these should increase the effectiveness of the public involvement program. Knowing the kinds of concerns that may develop will help an agency or utility prepare for events and hence come across to the public in a better light. It can also speed the process of mitigation by incorporating typical concerns into the planning and design processes early. As a result, compromise and consensus with the public is much easier to achieve.

The following items of public concern can be expected to surface on a major project:

1. Visual impacts to scenic and other areas.
2. Biological effects from transmission lines on people and animals.
3. The need for the project and its direct benefit to affected publics.
4. Conservation, and how it could postpone or cancel the project.
5. Impacts to historic and archeological sites.
6. Effects on natural resources, including wildlife, soil, and vegetation.
7. Establishing a precedent for future corridors.
8. Weighing the effects on people equally with cost and engineering criteria.

9. Economic impacts to people, including devaluation of property, crop damage, loss of farm and forest land, and the impact of construction workers on the community.
10. Use of public instead of private land.
11. Recreational impacts.
12. TV and radio interference.
13. Safety.
14. Public involvement in decision.

LESSONS LEARNED FROM THESE PROJECTS

Based on our experiences on these two projects and others of differing sizes, the following lessons and questions can be used when planning strategies for future projects.

Timing

Get all publics involved early in the process, particularly the potentially affected landowners.

Techniques should be used which include people in the decisionmaking process before the line comes on their property. Having a list of landowners available at the start of the project will help get information out early. However, before staff is sent to get that information from the county records, local leaders should be informed of what the agency has in mind. The question that arises is, should an agency get the public involved in the decision on the need for the project?

Audience

Use past experience and local contacts to define your publics.

In the early stages of planning, ask questions such as: "Who are your publics? Have all interests been identified? Who are the local leaders to contact for information? Who do we want to develop support from?" to make sure you have involved all the people in the process. This information should direct the techniques you use, your scoping process, and your plan.

Format

How you present your information, your representatives, your project, and the process to the public can determine whether your strategy is a success.

BPA did the following to insure a successful program:

1. Outlined the objectives of public involvement.

   Different parts of any organization will have different public involvement objectives or goals. For example, designing a meeting to do environmental scoping will be different than setting up a one-on-one contact to purchase land. Before anything happens, however, what is hoped to be accomplished must be communicated to all parties, including the public.

2. Realized that internal communication is as important as external communication.

   In any large organization with specialized functions, communication between players involved in a project is crucial. Any credibility built up with the public can be lost when different answers are coming from different parts of the same organization. Therefore, before any outside contacts are made, it is essential that all internal organizations know current aspects of the project and the public involvement strategy.

3. Informed political leaders about the project and the process for public involvement before general information was circulated. Keeping them up to date as the project develops makes them able to answer questions from their constituents.

4. Established cooperative agreements with agencies and local governments before the public involvement process began.

5. Found that different techniques work better than others. Used many techniques to reach each public.

   Often, when thinking of initial steps for planning a public involvement program, one technique, that is holding a meeting, comes quickly to mind. In some circumstances, to meet objectives or to meet a certain part of your public, this is appropriate. Too often, however, other less threatening techniques or meeting formats are forgotten.

   If you must have a meeting, make it as informal as possible while still retaining control. To do this, trained people are necessary. Individuals must practice and anticipate persons trying to disrupt the format of the meeting.

Sometimes it may be necessary to hire a specialist from outside the organization to resolve conflicts.

In most cases, one-on-one contacts are most effective, either through an open house, where people drop in just to talk about the project, or through personal visits. This insures that all voices are heard.

Defining the objectives for of each phase of a public involvement project can help sort out the kinds of activities required. Perhaps a joint meeting with another agency is appropriate, or making a presentation as part of a board's or commission's agenda. Maybe briefing sessions with political leaders is all that is necessary at the early stage. Sometimes a newsletter will accomplish more than an open house. The point here is to carefully think through and explore the various means for communicating, considering the audience.

The public should also see the same faces throughout the process.

6. Established a toll-free telephone line to a local office, staffed with skilled people, to be the main contacts for individuals, groups, and the media.

Effects on Decisionmaking

When designing a public involvement program, the requirements for public involvement and the benefits and risks involved must be clearly understood by both the program manager responsible for the project and the public. The following suggestions will help you develop your program, make it worth the time and effort of your staff, and insure that the public knows it is a sincere process:

1. Establish criteria for working public concerns into the decisionmaking process. Before the public participation program begins, there must be a clear understanding by members of the agency of just how the process will work and how the input of the public will be used.

2. Although an agency may be hesitant to bring sensitive issues out in the open, it usually is better to be the one bringing the subject up than to wait for the public to make it an issue.

3. Remember that all issues identified by the public are real issues, even though they may seem insignificant.

4. Follow through on all commitments made at meetings, during field work, or in any contact with the public. Be sure to document all these commitments.

5. Be prepared for the possibility that your time schedule may not always be the same as the public's.

6. Be patient and explain your technical restraints to the public.

7. Have decisionmakers meet with the public so that the public knows their concerns are being taken seriously by the "right" people.

8. Meld public involvement into the planning and decisionmaking processes so that it is just another part of doing business.

9. Schedule a follow-up evaluation of your Public Involvement Plan to see if the process can be improved and if the concerns of the public were used in the final decision.

NEW MODEL FOR FUTURE PROJECTS

Based upon the successful techniques developed during these projects, a new model for structuring public involvement in construction projects is being suggested by BPA staff. This model is going to be used in three test projects with the assistance of engineers, program managers, project managers, environmental staff, public involvement specialists, and others involved with the projects. The plan consists of the following elements:

1. Project description

   This will include a map of study area as well as a schedule of study phases, decision points, and other background information.

2. Establishment of a Public Involvement Coordination Team

   The Public Involvement Coordination Team will consist of a systems planner, environmental coordinator, design engineer, public involvement specialist, land specialist, construction specialist, and a local BPA office representative. The team will meet at major decision points to develop the overall public involvement strategy, decide on public involvement activities, define publics and problem areas, and evaluate public involvement.

3. Definition of publics and preparation of mailing lists

   This includes how the list is developed and maintained.

4. Public involvement needs analysis

   The analysis of public involvement needs will involve a history of past issues, information from old transmission line files, the characteristics of the study area and its publics, the publics information and participation needs, types of issues, and potential conflicts.

5. Selection of public participation objectives

   This includes involvement methods and activities, schedule, task descriptions, and assignment of lead responsibility for each task.

6. Documentation and evaluation of public comments

7. Follow-up evaluation of public involvement plan

Following this plan will assure that the need and purpose of the project are clearly defined and widely supported. By working as a team, the agency can insure that all relevant issues and concerns are identified and addressed. Reaching all publics will assure that only a feasible option is considered in the development of alternatives and mitigation measures. Areas of conflict or problems which are identified during the public involvement process can be dealt with efficiently by the team well in advance of land acquisition and construction.

CONCLUSION

Integrating the public into the planning and decisionmaking processes of a public agency or utility can be beneficial to the planning process. Early and frequent contact and information exchange can lead to better and more publically acceptable projects and programs and a better understanding by the public of engineering restraints and an agency's mission. Public perceptions of an agency, as a whole, can be made more favorable and can, in the long term, smooth the way for future projects.

The suggestions outlined in this paper and the questions that they raise can help program managers plan and implement successful public involvement experiences.

PUBLIC INVOLVEMENT IN THE ROUTE STAGE OF ONTARIO HYDRO'S SOUTHWESTERN ONTARIO 500 KV TRANSMISSION EXPANSION PROGRAM

A Poster Paper presented to:

FACILITY SITING AND ROUTING '84
ENERGY AND ENVIRONMENTAL SEMINAR

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ABSTRACT

The most intensive public involvement program ever undertaken by Ontario Hydro took place in southwestern Ontario throughout 1983.

A bulk transmission regional study to determine routes for four 500 kV transmission lines (totalling over 400 km) and a site for a 500/230 kV transformer station began in the fall of 1982 and concluded with the submission of an Environmental Assessment in December 1983. Public Hearings on the undertaking are expected in 1984.

The poster display and the following summary describe the scope of the activities designed to involve the public and point to the key results of the public programs.

I. Southwestern Ontario Route Stage Study

Task:

- Involve the public in the preparation of an Environmental Assessment for a major 500 kV transmission expansion program in southwestern Ontario.

Dimension:

- Routes required for four 500 kV transmission lines (over 400 km).
- Site required for a 500/230 kV transformer station.
- Total study area of 3,500 square miles.
- 13 counties and 63 townships affected.
- Do it all in 14 months.

Section II describes the scope of the public program implemented on this study. Section III points to the key results of the public involvement program.

II. The Public Involvement Program

General Description

A public involvement program for the study was initiated by Ontario Hydro. The program was designed to involve the public in all phases of the Route Stage study. While the contributions of the public are reflected throughout the study, the selection of recommended routes and a site was the responsibility of Ontario Hydro.

In a joint planning component of the program, representatives of the public on working groups and liaison committees met with the Ontario Hydro planning team on a regular basis throughout the route selection study, offering information, and contributing community preferences.

In addition, detailed project information was taken to the general public at key stages of the study for their review and comments. This was achieved principally through information centres, presentations, advertising and mailings.

The program commenced in November 1982 and concluded with the submission of the Environmental Assessment in December 1983. The program components are described in the following sections.

An overview of the involvement of the public in the key steps of the study is set out in Figure 1.

Working Groups

The working groups were formed from a broad range of interests including elected and appointed municipal officials, provincial ministries, conservation authorities, county federations of agriculture, local federated nature clubs and local groups representing agricultural, community/cultural, environmental, recreational, resource and electrical/energy interests. In addition to plenary sessions, subgroup meetings were held as required to discuss areas of specific interest and concern. A chairman was elected from amongst the delegates. All meetings were open to the media and general public.

The study areas and geographical boundaries of each group are shown in Figures 2 and 3.

The working groups were formed on the following basis:

(i) Prospective participants represented organized local land use, environmental or community groups with interests related to the siting of facilities within the study area;

(ii) Counties, regional municipalities and townships in the study area were invited to appoint delegates. Cities and towns that incorporate significant rural areas within their boundaries were also invited to participate;

FIGURE 1

Public Involvement Program - Ontario Hydro and Publics

Ontario Hydro	Citizens' Committees	General Public
Scale 1:50,000		
Collect environmental data and illustrate, establish citizens' committees, initiate technical studies	Identify environmental concerns and rank in order of importance to avoid	Introductory Status Report, Advertising and Information Centres, Nov. '82
Prepare constraint maps Identify and review alternative corridors/zones	Identify and review alternative corridors/zones with Ontario Hydro	
Define corridors/zones on mosaics		Status Report #2, Advertising and Information Centres, May '83
Scale 1:15,000		
Collect environmental data and illustrate, prepare technical and cost information, identify preliminary routes/sites	Develop location criteria, and review alternative routes/sites	
Prepare maps showing alternative routes/sites		Status Report #3, Advertising and Information Centres, Aug. '83
Evaluate and compare alternatives	Review	
Discuss with ministries, municipalities, interest groups	State preferences	
Recommendations and complete Environmental Assessment		Status Report #4, Advertising and Information Centres, Dec. '83

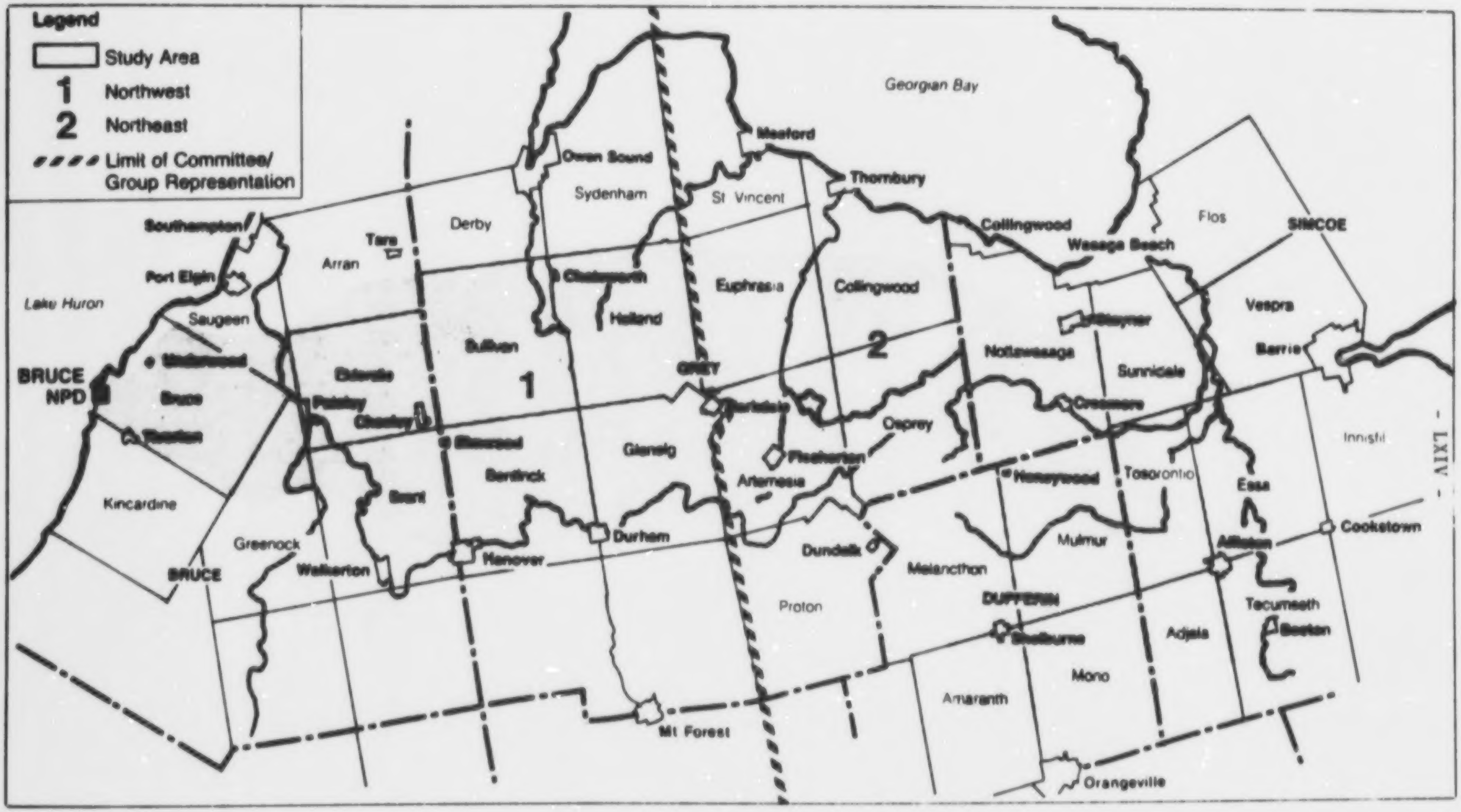
Legend
Study Area
1 Northwest
2 Northeast
Limit of Committee/ Group Representation
Georgian Bay
Lake Huron
BRUCE NPD
Southampton
Port Elgin
Saugeen
Bruce
Kincardine
Greenock
BRUCE
Walkerton
Arran
Tara
Elderslie
Paisley
Chesley
Brant
Derby
Sullivan
Bentinck
Hanover
1
Owen Sound
Sydenham
Chatsworth
Holland
Glenelg
Durham
Mt Forest
GREY
Meaford
St Vincent
Euphrasia
Markdale
Artemesia
Flesherton
Thornbury
Collingwood
2
Osprey
Dundalk
Proton
Collingwood
Wasaga Beach
Nottawasaga
Stayner
Creemore
Honeywood
Melancthon
DUFFERIN
Shelburne
Amaranth
Mulmur
Mono
Orangeville
Sunnidale
Tosorontio
Adjala
Flos
SIMCOE
Vespra
Barrie
Essa
Alliston
Tecumseth
Beeton
Innisfil
Cookstown

Figure 2
Bruce to Essa Study Area - Working Groups

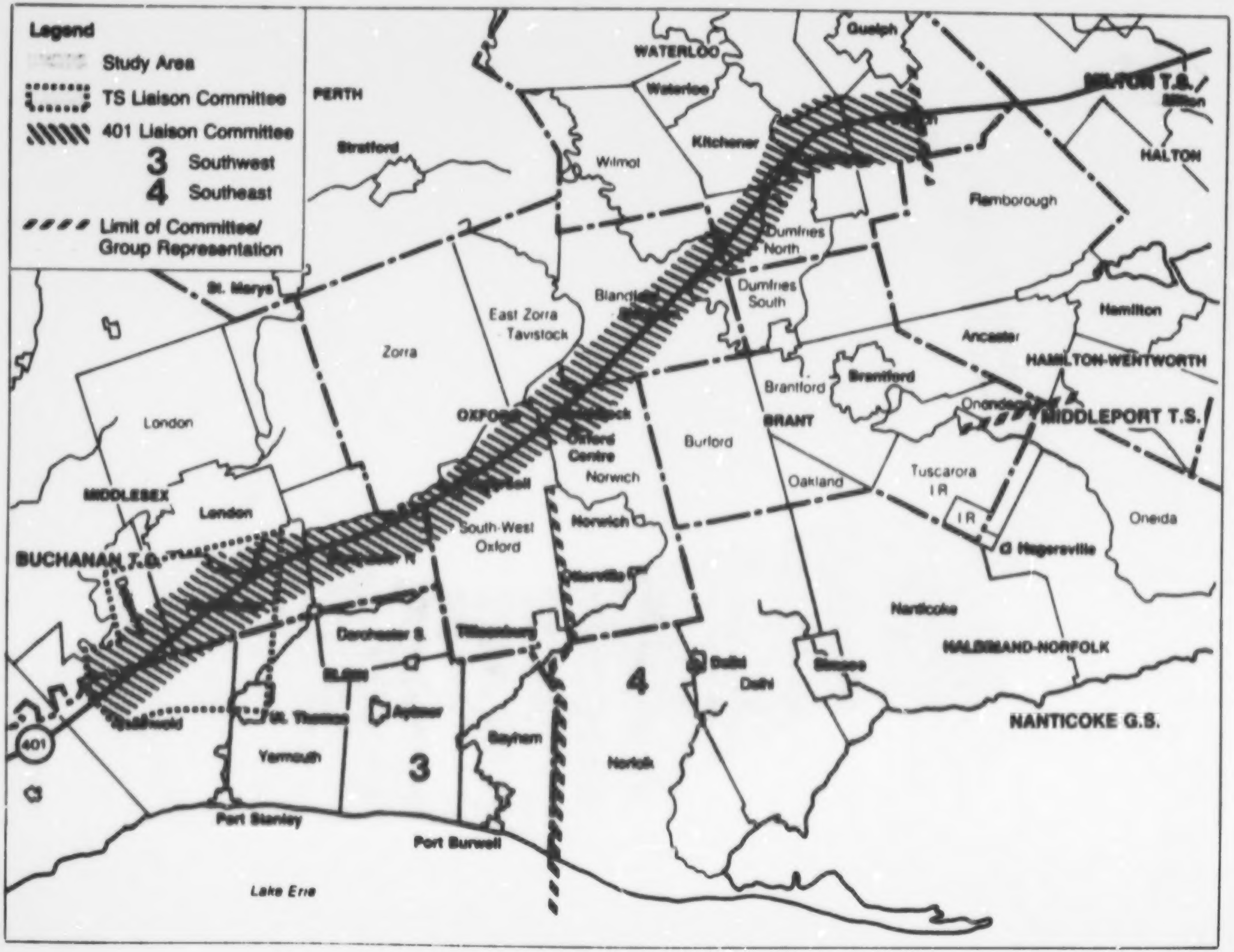
Legend
Study Area
TS Liaison Committee
401 Liaison Committee
3 Southwest
4 Southeast
Limit of Committee/ Group Representation
PERTH
Stratford
WATERLOO
Waterloo
Kitchener
Wilmot
Guelph
MILTON T.S./ Milton
HALTON
Flamborough
Dumfries North
Dumfries South
St. Marys
Blandford
East Zorra Tavistock
Zorra
Hamilton
Ancaster
HAMILTON-WENTWORTH
Brantford
Brantford
BRANT
Onondaga
MIDDLEPORT T.S.
London
OXFORD
Woodstock
Oxford Centre
Norwich
Burford
Oakland
Tuscarora IR
IR
Oneida
Hagersville
MIDDLESEX
London
South-West Oxford
Norwich
BUCHANAN T.S.
Dorchester S.
Tillsonburg
Nanticoke
HALDIMAND-NORFOLK
Delhi
Delhi
Simcoe
4
St. Thomas
Aylmer
NANTICOKE G.S.
401
Yarmouth
3
Bayham
Norfolk
Port Stanley
Port Burwell
Lake Erie

Figure 3
Supply to London Study Area – Working Group/Committees

(iii) Provincial Ministries with an interest in the study were invited to appoint local representatives to each of the working groups.

(iv) Individuals or organizations who expressed an interest in joining a working group were invited to attend the meetings as observers, and could only become an official member if approved by the working group itself.

(v) Members of the public and media were welcome to attend working group meetings as observers.

The notes of the working group meetings were recorded by independent notetakers, and were included in the reference material filed with the Environmental Assessment.

A summary of working group representation is provided in Figure 4.

Liaison Committees

In addition to the working groups, two geographically based liaison committees were established. One committee assisted in the study to find suitable alternative routes along the Highway 401 corridor. The other committee assisted in the study to find the most suitable site for the 500 kV/230 kV transformer station and met in London. Figure 3 shows the geographic boundaries of the two liaison committees.

These committees were made up of representatives of the municipalities within the respective committee boundaries, regional municipalities, counties, townships and major cities. Also on the committees were potentially affected County Federations of Agriculture, representatives from the ministries of Industry and Trade, Transportation and Communications, Natural Resources, and Agriculture and Food. The committees were more oriented towards the planning discipline and performed a review and advisory function during the study as compared to the developmental approach of the working groups.

Communication with the General Public

Communication with the general public focussed on the major phases of the study:

- introduction;
- identification of corridors/zones;
- identification of alternative routes/sites; and
- identification of preferred route(s) and site.

The public was contacted by way of status reports, advertising, information centres and presentations.

Status Reports

Information regarding the status of the project was mailed at key stages in the study to potentially affected individuals and groups within the

FIGURE 4

Southwestern Ontario Route Stage Study

Summary of Working Groups Representation

Organization	NW	NE	SW	SE
Municipal Governments	15	20	12	13
Conservation Authorities	2	2	3	2
Agricultural Organizations	8	12	13	13
Community/Cultural Organizations	2	1	1	1
Electrical Industry	1	1	1	1
Environmental Organizations	2	4	2	3
Recreational Organizations	2	4	2	2
Resource Organizations	0	1	2	1
Local Citizens' Groups	0	0	1	1
Ministries	3	3	4	3
Former Working Group Members		1	1	1
Total Appointed	35	49	42	41

following categories:

- Cabinet Ministers
- Conservation Authorities
- County Federations of Agriculture
- Deputy Ministers
- Direct Industrial Customers
- Directors of Planning
- Federated Nature Clubs
- Government Ministry Reviewers
- Interested Publics
- Libraries
- Working Group Members (Route Stage)
- Mayors and Reeves
- MPs
- MPPs
- Media
- Opposition Leaders
- Municipal Clerks
- Property Owners
- Provincial and Local Organizations
- Regional and Local Ministry
- Electric Utilities

The initial mailing list of about 5,000 persons in November 1982 grew to over 35,000 by the completion of the study.

Advertising

In addition to the distribution of status reports, paid advertisements were placed in newspapers and aired on radio stations throughout the study area. The objectives of the advertisements were to notify the general public as to the progress of the study at key stages, to announce the location of information centres, and to advise where more information could be obtained.

Information Centres

At the four stages of the study, project information was taken to the community by way of one day information centres in local halls throughout the study area. Project staff attending the centres presented the current study information, received information and views of the visiting public and answered questions. The number of locations for the centres at each stage is shown below:

Date	Subject	No. of Centres
November 1982	project introduction	16
May 1983	corridors and zones	25
August 1983	alternative routes and sites	26
December 1983	recommended routes and sites	25

Presentations

Presentations were made, upon request, to municipal councils, government ministries, public utilities, direct industrial customers and other interested groups or organizations. The purpose of these presentations was to inform the audiences of the study process and to receive their comments.

In addition, public officials were invited to preview information centres prior to their opening to the general public. MPs, MPPs and municipal officials, as well as the media, attended these previews. Project staff were available to review the progress of the study with these officials.

Media Program

In view of the scale of study activities in such a large portion of the heavily populated southwestern Ontario area, a media specialist was assigned full time to the study. The specialist continually travelled throughout the study area to ensure that the community press and electronic news media was well served with the current study information and with the utility's views on issues or matters under public discussion.

Distribution of Environmental Assessment

Copies of the three volume environmental assessment were mailed to all affected municipalities and many other affected or interested groups.

A forty-one page summary of the document was also prepared for more general distribution and it was forwarded to all on the 35,000 name mailing list.

III. Results

In the course of this 14 month study, Ontario Hydro:

- participated at 90 citizens' committee meetings to jointly plan for the selection of routes and a site.
- held 92 one day information centres in the affected communities.
- made over 50 presentations to municipal councils, government ministries and other interested groups.
- mailed over 100,000 pieces of project related information, including project newsletters, responses to enquiries and notices for the public hearings.
- monitored some 2,000 study related newspaper clippings, the majority of which were either balanced or favourable to the utility's views on the study issues.

As a result of these public involvement activities significant benefits have accrued to Ontario Hydro, to the government and approval authorities and to the affected public:

- public representatives made significant contributions to the planning studies for the facilities.
- the public reviewed and confirmed, corrected or added to the environmental data.
- the environmental assessment documents public views, especially those of the citizens' committees and affected municipalities.
- issues in the public forum were identified very early in the study. These issues were addressed throughout the study by members of the project team and are documented in the study.
- information sent to potentially affected property owners alerted the public to the progress of the study. While this resulted in court action questioning the validity of earlier approval authority decisions, the judicial review was initiated early, thereby keeping delay to the route stage approvals to a minimum.
- property owners, municipal contacts, and interest group representatives were all well known to the study team and this results in full knowledge and consideration of their concerns by Ontario Hydro, government review ministries and by the approval authority.

In its review of the Environmental Assessment for the study, the Ontario Government commended Ontario Hydro for its public involvement efforts.

As a result of the public program, Ontario Hydro has incorporated public views into its planning decisions and is now preparing for public hearings with full knowledge of the public affected by the proposal and the public concerns.

All of this helps to ensure the speediest possible approvals for the facilities.

SESSION III C - DECISION-MAKING

SAN FRANCISCO'S SEARCH FOR A LONG-TERM LANDFILL SOLUTION

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Consultants in Economic, Environmental & Social Planning

BACKGROUND I : The Rationality of the process

San Francisco, whose population density and city charter preclude a landfill within its boundaries, must look elsewhere to resolve a solid waste disposal crisis. State law now prohibits the traditional practice of filling in San Francisco Bay Wetlands in adjacent communities. Several investigations have been undertaken by the private garbage companies, which have the franchise to collect and dispose of San Francisco's refuse, and by the public administrators of the City and County of San Francisco, to identify alternatives which can reduce San Francisco's dependence on landfilling. Further studies have been conducted to identify potential sites, using as site selection criteria, identifiable environmental, economic, and political constraints. Some five years ago, an alternative disposal method was finally chosen, it included: modification of the wastestream to produce a relatively energy efficient fuel, burning of this fuel, and landfill disposal of the non-burnable segment of the wastestream and the residual burned ash. Critical to this plan was the selection and development of a landfill. Several sites were identified which meet San Francisco's criteria. Short term decisions as to the location of the new landfill were made in the interim, while the process for a more permanent solution continued. This process continues to this day.

In hindsight, San Francisco's search for a long-term landfill can be seen as a simple straightforward unfolding of events in which patterns are easily discernible, providing guidelines for other large-scale facility site selections. This description of the process of selecting a landfill site and of obtaining its permits, however, is misleading and leaves out much of the critical detail of the real process San Francisco has gone through to solve its landfill problem. The implication that the process is no more than the unfolding of a series of identifiable logical steps is wrong; the reality is that the path to selection of a site to solve a long-term need for a garbage disposal landfill for San Francisco has been tortuous, non-linear, and frequently irrational. All aspects of this process, identification of critical needs, the selection of disposal methods, the defining of criteria for site selection, the choice of actual sites and the obtaining of permits, have been interrelated and dynamic. Eventually, a site will be chosen and a pattern by which the site was selected and obtained will be apparent. This hindsight determination of the site selection process, however, should not be construed as programmed. To point out the pattern of what happened after the fact is rationalization. The real challenge for the actors in the site selection process is to derive from this, and other real life discussions of facility and route site selection, guidelines for accomplishing the site selection goal in the dynamic and fluid context in which such decisions actually occur.

BACKGROUND II : The Setting For The Story

The 1980 U.S. Census estimates that 674,073 persons reside within the 45 square miles of the City and County of San Francisco. San Francisco is the financial capital of the Western United States, as well as the administrative center for many leading U.S. corporations. The city does not have a large heavy industrial base; it is primarily a white collar town. It is also a major center of North American tourism.

San Francisco also has an extremely high population density of 14,000 persons per square mile. Approximately two-thirds of San Francisco's population reside in multi-family buildings, with about one-third of the population living in apartment buildings of ten or more dwelling units. This high population density is a primary reason for San Francisco's inability to provide a landfill disposal site within its own corporate boundaries.

Since the famous 1906 earthquake which devastated much of the city, city ordinances have barred refuse disposal in San Francisco. For most of the Twentieth Century, however, this restriction has not been much of a hardship. Up to 1964, San Francisco's solid waste was brought to its southern border where it was used to fill in a portion of the San Francisco Bay in the town of Brisbane in the adjacent county of San Mateo. Brisbane, a small town of 1000 to 2000 people, welcomed San Francisco garbage as a means for reclaiming unused marsh lands. In the early 1960's, however, press articles revealing that San Francisco Bay had shrunk by two-thirds in a century because of unregulated filling in of the Bay wetlands, spawned a strong Bay preservation movement. This movement culminated in the passage of State legislation severly restricting Bay filling. The days of unfettered disposal of San Francisco garbage were numbered. San Francisco had to abandon its traditional Brisbane landfill by 1964, and could only use an adjacent area called Sierra Park, the location for a planned future office park and marina, for an additional five years.

Since 1969, the solution to San Francisco's landfill disposal problem has been a series of short-term negotiated agreements to use landfill space in nearby landfills. The first proposed site for San Francisco solid waste was a landfill in Lassen County, a remote site over 200 miles from San Francisco, where refuse would have had to be hauled by rail. This project had reached the stage of active negotiations when a much closer site became available in the city of Mountain View, only 32 miles from San Francisco. Mountain View wished to develop a regional park on a part of its land which was unusable for development because excess groundwater pumping to irrigate fruit orchards had caused the land elevation to subside below sea level. The cost to San Francisco of disposal of its garbage at Mountain View was far less than Lassen County because of the much closer location of this site. San Francisco negotiated an agreement with Mountain View which was extended twice and which ended in late 1983. The story of San Francisco's search for a solution to its landfill problems for the post-1983 period is the subject of this paper.

This process for selecting a landfill site for San Francisco, however, cannot be understood without first discussing two other background elements, first, the regulatory climate in present-day California and its effects on solid waste management and second, the several institutions both private and public sector, involved in this decision.

As with many major site selection decisions in both the U.S. and Canada, the process of selecting a landfill site in California is not a simple matter of generating technical studies which allow one to chose the site most compatible with environmental and economic constraints. There is a long and cumbersome regulatory process requiring at least nine major and minor permits,and lasting from three to five years. For landfills in California, the first major hurdle is the Environmental Impact Report (EIR), a document required by the state law for all major development projects, showing potential adverse environmental impacts of the project, and the ways in which the impacts can be mitigated. The EIR report rarely takes less than a year. Following this, the project must obtain a county use permit which sets out the terms and conditions under which the project can be allowed to proceed. Finally, the last major regulatory hurdle is satisfying the concerns of the regional water quality control district which issues waste discharge requirements defining the technical engineering constraints under which the project must operate, and the procedures for monitoring landfill operations. In addition, there are less rigorous permits which it is usually necessary to obtain from county and state roads departments, regional air quality agencies, the state department of fish and game, and the county health department.

An even more critical factor, however, is the changing regulatory climate. New requirements and permits may be added to the regulatory process which radically change the balance of calculations in determining appropriate sites, and occasionally an offsetting concern or priority can arise to ease the path of site selection, as when in the mid-1970's, the energy crisis fostered a great interest in "waste-to-energy" garbage burning plants, and incentive schemes to encourage their development were fostered by the state government. Finally, even if there are no changes in the regulatory requirements, unforseen opponents can appear to attack the site selection though a host of governmental instruments, such as the referendum and intiative process for overturning unpopular political decisions, or court litigation. None of these elements can be predicted before the fact in landfill site selection, but one or more is almost certain to occur in as volatile an issue as selecting a landfill site.

Finally, one must also consider the entities included in this site selection process, the private scavenger companies which collect and dispose of San Francisco solid waste, and the city government which sets collection rates. San Francisco's garbage collection system is unique among American cities. Although the collection of city refuse is carried out by two private companies, GOLDEN GATE DISPOSAL COMPANY and SUNSET SCAVENGERS, they are closely regulated by city government. The city charter defines the boundaries of the collection districts and authorizes the city to set collection rates. A public-private partnership thus exists for this city's garbage collection systems, with GOLDEN GATE DISPOSAL COMPANY'S collection area serving mostly the downtown commercial area,and SUNSET SCAVENGER's area serving the bulk of San Francisco's residences. The companies themselves are also unique in American industry. They evolved from protective associations of the primarily Genoese Northern Italian immigrants who dominated the city's garbage collection system to ultimately become two major workers cooperatives. The companies are entirely self-owned by the workers who collect and dispose of the city's garbage. Finally, within city government, there has also been a shift in the agencies overseeing solid waste management. Traditionally, the city's end of the public-private partnership of garbage collection was handled by the city's Department of Public Works, reflecting the general attitude that solid waste management was a function akin to other municipal infrastructure services such as street sweeping or sewage treatment. In 1978, San Francisco's Chief Administrative Officer (CAO) shifted the jurisdiction of the

Solid Waste Program from the Public Works Department to the Office of Special Projects, directly under his personal control. The special project which necessitated this shift in agency jurisdiction was the search for a long-term landfill solution.

EVENTS

The first phase of San Francisco's landfill search process was an attempt to develop a waste-to-energy facility. Although the negotiations to allow disposal of San Francisco's refuse at the Mountain View Landfill eased the immediate disposal crisis, both the city and its scavengers desired a more long-term resolution of this problem. Initially, the solution seemed to be a waste-to-energy plant that would significantly reduce the volume of waste requiring landfill disposal. The mid-70's, when most of the waste-to-energy facility investigations took place, was the highlight of the alternative energy enthusiasm, an attempt to reduce dependence on imported foreign oil by developing alternate sources of energy such as garbage burning plants.

This focus on developing a technology to create energy from burning garbage, however, obscured several issues which needed to be addressed before a waste-to-energy facility could become a reality. First, it needed to be known whether such a facility would actually work. In the "hey-day" of engineering enthusiasm for garbage burning plants, at least three major technologies were suggested for accomplishing the task of creating energy from burning garbage. Few, however, had been tested to the point of being assured of operational success, and none had been tested in the California environment of strict air pollution control requirements. Second, there needed to be economic analysis to establish that the costs of constructing, and operating a garbage burning facility could be kept down to the point where the additional energy benefits would offset the increase in cost of disposal, so that there would be a net economic benefit to the scavengers and to the city residents from developing a garbage burning plant. Finally, and most important, there was a need to continue to address the problem of landfill disposal. Burning garbage would only reduce the volume of the San Francisco wastestream by about two-thirds, and would only delay the time when San Francisco would have to find a landfill which could take the unburned segment of the refuse stream, and the ash residue from burned garbage.

None of these issues were seriously considered in the initial consideration of a waste-to-energy plant. The impetus for developing such a plant, at first, came from SUNSET SCAVENGERS who owned the land in Brisbane where San Francisco garbage had traditionally been dumped. A waste-to-energy plant seemed a way to dramatically increase the value of the completed landfill, and to increase the revenues of both scavenger companies, since the construction and operation of the garbage burning plant would be carried out as a SUNSET/GOLDEN GATE joint venture company called SANITARY FILL COMPANY. Similarly, San Francisco was also taken with the enthusiasm of developing a milestone technology to burn garbage, and in this way put itself in the forefrount of progressive North American cities.

As a consequence, several technical analyses were undertaken which showed that a garbage burning facility was indeed the answer to San Franciso's waste disposal problem, and that the best site for such a facility was the completed Brisbane landfill adjacent to an existing transfer station, owned and operated by the SANITARY FILL COMPANY.

Before such a development could actually be carried out, however, several events occured which considerably slowed, and at times halted the development of the waste-to-energy plant. In the first place, it became apparent that garbage burning technology was in fact quite shaky. Several small and large American cities moved more quickly than San Francisco, and built state-of-the-art facilities which turned out to be white elephants. Bridgeport Conneticut built a prototype of the technology that San Francisco was considering, the burning of refuse derived fuel (RDF), that operated only sporadically, and was eventually abandoned. Baltimore Maryland constructed a plant of even more exotic technology, gas pyrolysis, that never worked at all. Fairly quickly, as a consequence, the bond houses who were to provide the financing for waste-to-energy facilities, became cautious in their approval of garbage burning schemes, and began to demand assurance of long-term back-up commitments for landfill availability to accomodate the entire wastestream if the waste-to-energy projects were unsuccessful, or only partially successful, and the reduced wastestream of ash residue and unburned garbage if the plant worked as envisioned.

San Francisco's CAO also reacted to the failure of early garbage burning plants by taking a much more direct role on the development of the waste-to-energy facility. He assumed direct control of all solid waste operations in the city, demanded control of the negotiations with prospective vendors or garbage burning technologies, and insisted that the engineering firms designing the San Francisco waste-to-energy plants assume liability for the operations of the untested technology once construction was complete.

These actions slowed considerably the progress of the waste-to-energy project. Other events also contributed to this lengthening out of the process of developing a garbage burning facility. Environmental analyses revealed that it was very unlikely that such a plant could be operated without significantly increasing emissions of air pollutants. Such a situation would require costly control equipment, and an agreement to take actions that would offset the increases in emissions by paying for other compensating air pollution reduction activities.

Finally, a shift in political attitude occured in Brisbane that eliminated the availability of the former landfill as a site for the garbage burning factory. Fostered by the concern of a large real estate developer who proposed to build homes in the vicinity of the proposed waste-to-energy plant, a movement was begun in Brisbane to oppose this facility. The movement succeeded in overcoming initial city council support for the facility, and eventually an initiative was placed before the city voters to prevent the use of the proposed site for a garbage burning plant. Thus, Brisbane, which had accepted San Francisco's garbage for 50 years, decided that it could not allow this same garbage to be brought to the city and burned.

Despite the defeat of the proposal to build the garbage burning plant in Brisbane, there was still an effort underway in San Francisco to construct such a facility. This effort, though, was minimal. The scavenger companies had no involvement in this project, having been entirely preempted by the city's CAO, and although he selected a vendor for design of the facility, and continues today to investigate potential sites, the waste-to-energy project is mostly simmering on the back burner.

The major emphasis of the search for a solution to San Francisco waste problem became, instead, the effort to find a landfill that would accept San Francisco's garbage. This problem, in turn, was defined as a two-part task--the immediate need to locate a landfill to take San Francisco garbage for a limited five year period after the 1983 deadline for getting out of Mountain View, and secondly, the need to find a landfill that could make an extended commitment to receive San Francisco waste.

Both the City of San Francisco and the private scavenger companies participated fully in the landfill search. The focus of each participant's involvement, however, was quite different. The scavengers felt that control of landfill disposal was becoming the major factor in determining the success of their solid waste business. Whereas traditionally, the private garbage companies have made their profits mostly from efficient garbage collection operations, in recent years, the growing scarcity of available landfill space has made the disposal side of scavenger business the most profitable aspect of the solid waste management. The scavengers, therefore, sought to secure a commitment from San Francisco to take its garbage to a medium-sized landfill owned by GOLDEN GATE as the solution to the immediate crisis, and to develop a new major landfill as the site for long-term disposal of San Francisco refuse.

San Francisco, however, has been ruled by several different, not always consistent motives. The city's main interest was probably "peace of mind", both in the short and long run. Secondary motives, however, particularly the feeling of the CAO that he had to control the selection process as much as possible, also figured significantly in the search for a landfill. The principal means by which the CAO has attempted to control this process has been his insistence that the landfill search should be a competitive process with the city dictating the terms of the competition. For the first phase of the landfill search, the attempt to find short-term landfill space for San Francisco's garbage, the terms of the competition were that the city would send its garbage to the first landfill which could provide all of the necessary permits to allow disposal of San Francisco's refuse. For the second phase, the search for long-term landfill availability, the terms of the competition have supposedly been that the long-term contract for San Francisco's garbage would go the the landfill which would offer the cheapest price to dispose of the city's solid waste.

In the search for a five-year site to receive San Francisco refuse after the 1983 closure of the Mountain View Landfill, GOLDEN GATE attempted to get San Francisco to come to a site about 75 miles from the city, the B&J Landfill in Solano County. GOLDEN GATE was at a disadvantage, however, on several counts. All other sites under consideration were closer than B&J to San Francisco, so that it was presumed to be more expensive to haul San Francisco garbage to this site than to any other. In addition, the scavengers disagreed among themselves on the B&J site. GOLDEN GATE favored it because it owned the site; SUNSET, however, which wouldn't receive any of the increased revenues from garbage going to B&J, favored an extension of the Mountain View contract and several other alternatives. Finally, and most important, one of the competitors to GOLDEN GATE, the OAKLAND SCAVENGER's Altamont Landfill, (55 miles from San Francisco), had almost all of the required permits, and a willing county government, to allow disposal of San Francisco garbage, whereas the permitting activity necessary to allow B&J in Solano County to receive San Francisco garbage would take at least one and a half years.

Since San Francisco's CAO insisted that the terms of the competition would be that "the first one in the door with all necessary permits gets the contract", this difference in length of time required for obtaining landfill permits was a disadvantage that GOLDEN GATE could not overcome. Despite the pretense of a careful consideration of economic, environmental, and political factors, once it became apparent that the Altamont site would be permitted and ready to receive San Francisco garbage sooner than any other site, no other site was in serious contention for the short-term contract. Moreover, because the OAKLAND SCAVENGERS had no competition, they were able to negotiate a very high price with San Francisco

The search for a long-term landfill site for San Francisco's garbage has pitted many of the same competitors against each other, as in the earlier contest for the five-year contract. The landfills under consideration are generally those that the city considered earlier, and as before, despite its seemingly uncompetitive fee structures, the OAKLAND SCAVENGER's Altamont site is in top contention to become the chosen site. As mentioned earlier, San Francisco's CAO is also conducting a similar search process, competition between privately owned landfills. The terms of the competition have now shifted; the selection of a long-term landfill is now to be based on cost rather than expedience of delivering a permitted site.

There have been significant changes, however, among the San Francisco scavengers. GOLDEN GATE and SUNSET have agreed to support a joint venture project to develop a major new site, the Lynch Canyon Landfill, whereas before each had supported a seperate landfill option. Lynch Canyon, like the B&J site GOLDEN GATE had proposed for the short-term contract, is located in Solano County. It is huge and could, if developed, take San Francisco's garbage as well as the refuse from nearby Solano and Napa County communities for 80 years. There is also, however, a substantial amount of political opposition to Lynch Canyon, so that it is by no means certain that the site will be permitted as a landfill. At present, the homeowners association of a development 3 miles away, which is spearheading this opposition has qualified a referendum and an intitiative for the November 1984 ballot in Solano County. If the referendum and initiative get voters approval, Lynch Canyon will not be able to be developed as a landfill, and there will be strict limitations on the volume of garbage that can be disposed of from communities outside of Solano County.

Before these Lynch Canyon developments occured, however, the San Francisco scavengers were able to get approval for a permit to take San Francisco garbage to B&J for the five year period from 1988 to 1993. San Francisco's CAO agreed to a contract with B&J for this period because it was thought that this might ease the way for approvals of Lynch Canyon.

Thus, San Francisco today is in essentially the same position it was in 1964, when it first became apparent that the city's traditional disposal site would have to be closed. The city has negotiated a series of short-term contracts with local landfills, while the major problem remains. Although the city and its scavengers have hired experts, conducted numerous studies, and held countless numbers of high-level negotiations with landfill owners and community politicians, San Franciso has been unable to work out a long-term landfill solution to its waste disposal problem.

As a consequense, both the city and its scavengers have suffered loss. Without a landfill of their own to take San Francisco's garbage, the scavengers have seen their prospects for future business growth diminish. If they are not successful in being able to control the disposal side of their business, there is a real possibility that they may ultimately be bought out by one of the major solid waste agglomerates. WASTE MANAGEMENT, BROWNING FERRIS, or SCA. These are three companies who, during the 1970's, through skillful buyouts of companies like GOLDEN GATE and SUNSET, acquired control of much of the previously small-scale garbage industry in North America. Thus, for the scavengers, their industrial survival is at stake.

San Francisco has also lost by continually being on the short leash of her temporary land disposal contracts. No city would willingly make itself so beholden to other communities for major services such as solid waste disposal. Even where a city is forced to seek outside its boundaries for the means of providing services, it always seeks the stability of long-term renewable contracts. Certainly, the cities who purchase water from San Francisco's own Hetch-Hetchy water project do this, or even San Francisco's sister city of Oakland in its negotiations with the private OAKLAND SCAVENGERS over garbage disposal at the Altamont Landfill. The cost in municipal flexibility and actual revenues from always being in an unfavorable bargaining position is incalculable. San Francisco may yet achieve a resolution of this garbage crisis, but until it does so, its solid waste management future is shaky and unenviable.

A MODEL FOR ENVIRONMENTAL NEGOTIATION:
ITS ROLE IN SITING AND ROUTING OF ENERGY FACILITIES

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The views presented in this paper are those of the authors and do not necessarily represent the views of the Department of the Environment.

A MODEL FOR ENVIRONMENTAL NEGOTIATION: ITS ROLE IN SITING AND ROUTING OF ENERGY FACILITIES

INTRODUCTION

Environmental regulatory decision-making surrounding energy facility siting has given rise to situations of conflict reflecting the inconsistencies inherent in achieving society's objectives for sustained economic growth on the one hand and the protection of environmental quality on the other. In fact, the process has been well described as a 'balancing act' involving technical, economic, environmental, social and political considerations. This paper is an attempt to propose certain changes to existing environmental regulatory decision-making processes to improve their capacity to anticipate and more constructively manage these conflicts. Specifically, it explores the possibility of identifying opportunities in federal regulatory processes where, at certain points, inclusion of planning and decision-making mechanisms would allow more meaningful representation and consideration of a wider range of public interests thereby minimizing actual or potential environmental disputes. The idea here is that, if environmental regulatory processes are to serve the public interest, there must be greater opportunity for those persons representing the public interest to be involved in the decision-making process. Implicit in a proposal for change is the premise that the cause of sound environmental decision-making is not served if significant[1] social and political conflicts are not resolved in the process, regardless of how right the decision may be from a technical standpoint. This view further assumes that 'environment' includes all aspects of human environment, including social, political, cultural and economic phenomena[2].

The incentive to explore this concept arose out of one of the newest conflict resolution mechanisms in the environmental field, 'environmental mediation'. An examination of this concept led to the conclusion that certain of its 'innovative' characteristics and inherent principles might be utilized to achieve our objectives for improving existing environmental regulatory decision-making processes.

The paper begins with an examination of the concept of environmental mediation focusing particularly on its innovative characteristics and its potential application for resolving environmental conflicts.

Part two briefly summarizes two federal regulatory processes, the National Energy Board Act and the Atomic Energy Control Act, identifying specifically those provisions in the statutes which could provide opportunity for early conflict resolution.

the Canadian context.[5] Principal among these differences is the ready access to courts available to U.S. private citizens and public interest groups for litigating class actions in environmental matters. The highly litigious system of environmental regulation in the U.S. has resulted in excessive delays and has provided the various parties to an environmental dispute with the motivation to enter into voluntary negotiations in an effort to achieve consensual resolution of the problem. Hence environmental mediation is perceived to be an effective dispute resolution mechanism.

By contrast, individuals and groups in Canada are traditionally less litigious, and as well, are severely restricted in civil actions by the many procedural hurdles, not the least of which is the definition of what constitutes a class action. As a result, non-governmental parties without a specific direct interest in environmental decisions are limited to political lobbying and public pressure tactics to influence environmental decision-making processes.

In addition to these factors, Canadian environmental regulatory decision-making processes are substantially controlled by government through administrative procedures. For environmental mediation to be useful in Canada therefore existing environmental regulatory processes and non-regulatory environmental decision-making processes such as the Federal Environmental Assessment and Review Process require refinement to facilitate a wide acceptance of the principles underlying the concept as well as its use as a conflict resolution mechanism. In other words, the refinements as proposed, embodying many of the principles of mediation, if introduced into existing regulatory environmental decision-making processes, could begin to put administrators, industry, and the public at greater ease with the concept of negotiation and consensual decision-making for resolving disputes in facility siting and routing.

1. MEDIATION: A DEFINITION AND FIRST PRINCIPLES

The most frequently cited definition of mediation has been advanced by Gerald Cormick, a leading practitioner from the United States; he describes it as:

> A voluntary process in which those involved in a dispute jointly explore and reconcile their differences. The mediator has no authority to impose a settlement. His or her strength lies in the ability to assist the parties in resolving their own differences. The mediated dispute is settled when the parties themselves reach what they consider to be a workable solution.[6]

Put simply, the features of the process are negotiation among the parties with the assistance of a neutral third party to achieve consensus. Inherent in Cormick's expanded definition are the several essential principles of the process:

(1) The process is voluntary. The parties must be willing to enter into negotiation and are not compelled to do so at the recommendation of a mediator. One report has pointed out that voluntary participation in the process does not preclude resort to any other remedy available to a party;[7]

(2) The parties are brought face-to-face to negotiate the issues they have identified;

(3) The mediator facilitates the process particularly by improving communication among the parties;

(4) Agreement is reached by consensus; the mediator has no authority to impose a settlement; and

(5) The proceedings are kept confidential by the mediator in order to gain and maintain the trust of the concerned parties.

Given that inter-party negotiation is the essential feature of mediation, the process becomes an alternative to the more adversarial forms of dispute resolution, provides disputing parties with a forum to communicate their concerns, to exchange and challenge each other's information, to clarify the issues and to identify alternative approaches for reaching agreement.

But what are the limitations to the wide use of environmental mediation as a conflict resolution mechanism? First, mediation comes into play when conflict reaches a point where direct, face-to-face negotiations have reached an impasse and one or more of the parties feel that progress towards settlement has ceased. In other words, environmental mediation may be described as a crisis intervention technique.

Secondly, not all environmental conflicts can be mediated. One author has concluded that the mediability of any dispute is inversely proportional to the breadth and complexity of the issues involved.[8] He goes on to opine that disputes which pertain to activities or undertakings which are confined geographically but involve various government agencies, levels of government, and broadly based industrial and environmental interest groups, are usually very difficult to resolve because of the number of affected constituencies and the very diverse nature of their respective interests. He does conclude, however, that the resolution of these disputes is possible when innovative approaches are developed for rationalizing the costs and benefits associated with the activities. Included in this category would be energy facility-siting disputes.

If it is the case that environmental mediation has limitations for its wide use for resolving environmental conflict, what are the possibilities for refining exisiting environmental decision-making processes:

(1) to provide meaningful representations in the decision-making process of a wide range of public interests to respond to complex issues with far-reaching environmental implications;

(2) to facilitate the development of a single, adequate and widely accepted information base useful to all parties in negotiations with full access to the information to allow for effective presentation of all interest;

(3) to provide sufficient funding to allow all identified parties to a cause to present their concerns;

(4) to expedite the process; and

(5) to ensure sound environmental decision-making?

It is suggested that existing environmental decision-making processes could be improved by including in the administrative procedures dispute management processes which in most respects conform to the criteria identified in the definition of mediation, and which could serve to resolve conflict before stalemate occurs. While several environmental mediation practitioners from the United States have stated that such processes have little likelihood of success, they are speaking from the American experience where litigation is a frequent remedy whereas 'facilitation' and 'conflict anticipation' are less decisive mechanisms. Canadian environmental decision-making processes on the other hand, favour informal consultation with interest groups rather than public adversary hearings and have set a climate more amenable to increasing the scope of participation to include all the affected parties in order to take fully into account "the public interest". The concept of environmental mediation has considerable potential to achieve goals of this nature. However, there also exists the need to design processes for inclusion in existing regulatory processes to provide opportunities where negotiation could be conducted among all the affected parties, facilitated by a neutral third party, to achieve more consensual decision-making.

that in the Board's opinion may be affected by the granting or the refusing of the application". The Board has inserted many different conditions in certificates issued for projects; some of these have required the applicant to undertake further studies and tests and to furnish these to the Board or to undertake environmental protection requirements.

The National Energy Board Act and Regulations provide only a basic framework for hearing procedures, and much is left to the discretion of the Board. The Act directs that hearings regarding the issue, revocation or suspension of certificates or licenses for export or import of gas, or leave to abandon a pipeline or international power line shall be public. The Board may hold public meetings on other matters if it considers it advisable to do so.[20] (emphasis added)

The Act provides that the Board has exclusive jurisdiction to determine standing and to date the Board has never denied standing to any intervenor[21].

Board hearings for major frontier projects are usually held in Ottawa; when sociological and environmental issues are to be considered, it is the Board's practice to move to the regions affected by the proposed facility siting. Some observers have opined that the regional meetings tend to be of secondary importance thereby leading to feelings of alienation on the part of those who come in 'cold' to the regional meetings.[22] Finally, Section 29.6 provides that the Board may fix an amount for actual costs incurred by any person making representations to the Board.

The National Energy Board Act has incorporated into its scheme provision for the appointment, by the Minister, of a negotiator or an Arbitration Committee to settle compensation claims related to the acquisition of lands or for legislative damages suffered from company operations[23]. Section 9 provides that the Governor-in-Council may appoint and fix the renumerations of experts or persons having technical or special knowledge to assist the Board in any matter in an advisory capacity.

2. THE ATOMIC ENERGY CONTROL BOARD

The British North America Act of 1867, through a 1930 amendment, conferred the ownership and control of resources on the provinces. Uranium and nuclear matters became the exception to this division of powers, with the passage of the Atomic Energy Control Act in 1946.[24] The Act was based on Section 92-10(c) of the BNA Act which allows the Parliament of Canada to declare a "local work and undertaking" to be "for the general advantage of Canada".[25] Thus formal regulatory authority resides with the federal Atomic Energy Control Board.

The primary role of the Atomic Energy Control Board is set out in the Atomic Energy Control Act[26] which authorizes the Board, inter alia, to control atomic energy materials and equipment in the interest of national and international security. The Act confers on the Atomic Energy Control Board and on Cabinet a great array of control powers. By virtue of Section 3 of the Atomic Energy Control Act, the Board is the agent of the Federal Crown and is subject to any general or specific directions by the Minister under Section 7.

Many of the Atomic Energy Control Board's powers are exercised through the agency's Atomic Energy Control Regulations[27]. These establish a comprehensive licensing system. Briefly, there are two formal licensing stages, construction approval and approval to commence operation. Preceeding these stages is the site approval stage. The Board does not consider this phase part of its licensing process yet site selection obviously has implications for health and safety and hence early public debate is important. In addition, the agency's inevitable involvement in site selection is impossible to sever from the steps that culminate in agency decisions on the construction and operation stages.

3. FEDERAL ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS (EARP)

This federal environmental assessment process is a non-statutory requirement, based on a Cabinet decision of December 20, 1973 as amended by Cabinet on February 15, 1977[28].

Under the Cabinet Minute the Minister of the Environment was authorized to establish a process to ensure that:

(a) environmental effects are taken into account early in the planning of new federal projects, programs and activities;

(b) an environmental assessment is carried out for all projects which may have an adverse effect on the environment before commitments or irrevocable decisions are made; projects with potentially significant environmental effects are submitted to the Department of the Environment for review;

(c) the results of these assessments are used in planning, decision-making and implementation".[29]

This authority has been clarified by a 1979 amendment to The Government Organization Act[30] which makes it clear that the assessment powers and responsibilities are vested in the Department of the Environment. Federal projects are those initiated by federal departments or agencies, and projects proposed by agencies outside the federal government that involve federal funds or federal property. Federal regulatory agencies and proprietary crown corporations are not specifically bound by the process. They have been 'invited' but not directed to participate.

The detailed procedures are as follow: As early as possible in the project planning process the initiating department or agency ('the initiator') must screen projects for potential adverse environmental effects. The "initiator" is the government department or agency either proposing the project, or charged with administration of federal funds or property involved in a project proposed by a private developer ('the proponent'). Screening guidelines in matrix form for various categories of projects have been developed by the Department of the Environment.[31] The Department has also suggested the following criteria for making screening decisions: magnitude, prevalence, duration and frequency, risks, importance, and mitigation.

As a result of initial screening one of three decisions must be made by the "initiator":

1. There are no potential adverse environmental effects, or adverse environmental effects are not considered significant;
2. The nature and magnitude of potential environmental effects cannot be determined by preliminary screening; or
3. Anticipated adverse environmental effects are considered to be signficant.

It is important to note that the Screening Guide specifies that environmental effects are judged to be significant if they create or have the potential to create controversy in the public or in professional communities.

If decision 1 is made, no further reference to the process is required. Decision 2 requires that the "initiator" prepare an Initial Environmental Evaluation (IEE). In this latter case the IEE will permit the "initiator" to make a decision as to whether alternative 1 or 3 should be followed. If decision 3 is made either initially or following preparation of an IEE, then the Executive Chairman, Federal Environmental Assessment Review Chairman, Federal Environmental Assessment Review Office (FEARO), Department of the Environment, will establish a Panel to review the project.

The roles of each of the parties to the process may be summarized as follows:

1. Proponent Agency
   - interprets Department of Environment guidelines and conducts initial screening and/or environmental evaluation to determine whether potential

environmental impacts of project are significant;
- interprets review panel guidelines and prepares E.I.S. accordingly; may seek clarification of guidelines from panel;
- proceeds with project if judged to have no significant residual detrimental environmental effects or if approved by Minister upon receiving EARP report.

2. FEARO
- recruits members of federal Public Service to review panels;
- administers EARP;

3. Review Panel
- prepares guidelines for preparation of the environmental impact statement (EIS);
- may consult with public interest groups in preparing guidelines;
- conducts public meeting to review E.I.S.;
- may issue statement of deficiencies requiring further information or analysis be provided in the E.I.S., and hold subsequent public meeting to complete review of E.I.S. upon receipt of supplementary information;
- makes a report with recommendations to the Minister of the Environment.

4. Affected Persons and Public Interest Groups
- may be consulted re guidelines for the E.I.S. at discretion of review panel;
- may be consulted by proponent in preparation of E.I.S. at proponent's discretion;
- participate in public meetings for review of E.I.S.

5. Minister of the Environment
- appoints members to review panels who are from outside the federal Public Service;
- in conjunction with the Minister responsible for the initiating agency, makes final decision on projects which have gone through EARP;

In terms of relative power of the parties to the process, the proponent or initiating department has greater control over the process than the affected public. For example, the proponent can potentially decide that there are no significant impacts and not proceed to a review process.

III

A MODEL FOR ENVIRONMENTAL NEGOTIATION

The development of a model for environmental negotiation arose out of two basic tenets. The first was the belief in the concept of environmental mediation as a more effective dispute resolution mechanism to better reflect the interests of all affected parties, but acknowledging its limitations for the Canadian regulatory context. The second premise was that the public hearing process should not be the only technique used to resolve environmental disputes; that many of the issues which are left to the public hearing could be dealt with earlier, could be more effectively resolved to the satisfaction of all the affected parties through a process of negotiation, facilitated by a neutral third party, thereby narrowing the issues before a hearing starts. Because techniques which assist negotiation have been developed in other fields, their application to environmental disputes is tenable more importantly the public hearing process as it presently functions, where all the issues are left for decision to the one forum, fails to provide opportunity for truly consensual decision-making in the public interest.

With the features of environmental mediation in mind as well as the concept of preliminary or pre-trial hearings, a model for the use of environmental negotiation was developed for use at specific decision-making points in environmental regulatory processes. The model had to address how to deal with procedural and substantive issues, matters related to the gathering and sharing of all relevant and necessary information, funding of the affected parties, and fair, competent neutral leadership for conducting the negotiations. These and other issues are fully discussed in Part III.

A. THE NATIONAL ENERGY BOARD:

Pursuant to the National Energy Board Act, the National Energy Board has full and exclusive jurisdiction to make any order or give any direction in 'the public interest'. The Board therefore could direct that an environmental negotiation process be conducted to resolve specific issues such as facility siting and route selection[32]. Because the National Energy Board shall recommend to the Minister such measures as it considers necessary or advisable in the public interest for the control and supervision of the development of energy[33], the Board could, in this advising role, establish a precedent of directing early environmental negotiation among the parties affected by proposed development, in order to identify potential issues for negotiated resolution. In order to facilitate this process the Board has the mandate to utilize, wherever appropriate, agencies of the Government to facilitate an order or direction for environmental negotiation.[34]

With this broad mandate the National Energy Board could facilitate the inclusion of environmental negotiation processes at three different stages in the regulatory process under the Act:

(1) The site planning stage: when a company makes an application to construct a pipeline, it must accompany the application with a plan, profile and book of reference about the proposed site. Construction may not begin without a certificate from the Board granting it leave to begin. The use of an environmental negotiation process at this stage could benefit all parties having an interest in the proposed facility site. The process could facilitate an identification of the environmental issues which would likely arise, their complexity and the possible mitigative measures which would be necessary if development proceeded. The process could facilitate communication between industry and the parties likely to be adversely affected by the development. Early consultation could facilitate agreement about some of the issues provided all the parties adversely affected had been consulted and negotiation techniques utilized. Lines of communication among the parties could be established making further negotiation possible throughout the progress of the development.

(2) The application stage: Once industry has decided on a facility site, it must make an application for a certificate to proceed with the construction phase. In accordance with the Board's Rule of Practice, the application must be accompanied by detailed environmental information[35]. The Board could direct that environmental negotiation be conducted among the affected parties for the preparation of this report. Such a process would encourage the identification of mutually agreed upon, anticipated environmental problems and problem areas. Attention could also be given to detailing mitigative measures and follow-up processes for ensuring their satisfactory completion. Certain issues would undoubtedly remain contentious but identification at this stage would both provide early warning to allow preparation for their consideration at later stages.

(3) Upon the calling of a public hearing: The Board must hold a public hearing where a person adversely affected by a proposed construction has filed a written statement opposing such development[36].

Since the parties adversely affected by the development would be identified through the filing of their objection statements, an environmental negotiation carried out at this stage could facilitate the identification of the issues for conflict anticipation purposes. Negotiation conducted at this stage could be used to resolve some of the identified disputes; those issues which remain unresolved could be dealt with at the public hearing stage. This would serve to focus the public hearing process on the more contentious issues.

If the National Energy Board directed that environmental negotiation was to be utilized as an integral part of its administrative procedures to assist it in its deliberations concerning the public interest, presumably the agreements arising out of the environmental negotiation process would be given due weight by the Board in its final deliberations. At the same time, however, it would be essential that the use of environmental negotiation would not preclude the parties adversely affected by the proposed development from utilizing other approaches to bring their concerns to the attention of the developer and the Board, if environmental negotiation processes failed. Approaches such as political lobbying and use of the media come to mind especially if the environmental negotiation process failed to achieve stated objectives.

The choice of a facilitator for the environmental negotiation process would be critical to its success. Clearly the person would have to be acceptable to all the parties involved. Critics of this proposed process will identify this aspect as a problem area. They will argue that a facilitator appointed by the National Energy Board could not be a neutral third party . In response, it is argued that the process will likely be successful if all the parties strive to ensure that it does work to everyone's satisfaction. It is suggested that the issue at this stage is to attempt to facilitate more negotiation to achieve consensual agreement among the parties to a proposed development early in the process to identify and resolve, so far as possible, conflicts arising out of perceived environmental impacts.

B. THE ATOMIC ENERGY CONTROL BOARD:

It is recommended that an environmental negotiation process should be instituted by the Atomic Energy Control Board in accordance with its mandate under The

Atomic Energy Control Act[37] for the pre-site approval stage. Site selection obviously has implications for health and safety and to ensure early public debate and agreement, where possible, the Board could require as a condition of being licensed that a proponent announce publicly its intention to seek site approval and satisfy the Board that adequate public debate had taken place including the use of environmental negotiation among the affected parties.

This would achieve two ends. It would enable debate on general issues to take place at the provincial level at an early stage. Second, it would bring environmental questions to the fore when they should be raised.

The Atomic Energy Control Board[38] is instructed to act in the national interest in the control, development and use of nuclear energy. Its task involves health and safety measures. But, the flexibility of its mandate gives the Board ample scope for structuring its licensing tool to nudge the proponents in the direction of a environmental consultation process. This would benefit not only the public at large but also its perception of the Board as an effective regulator truly acting in the public interest.

C. INCENTIVES FOR IMPLEMENTING A MODEL OF ENVIRONMENTAL NEGOTIATION IN EXISTING ENVIRONMENTAL REGULATORY PROCESSES

It is all very well to argue for improving existing federal regulatory processes to achieve more balanced environmental decision-making, but without clear policy directions being provided to regulatory or administrative tribunals such reforms are not likely to take place. There are initiatives which could provide the necessary impetus and these are discussed in this section.

1. Promotion by Government

Parliament has given the National Energy Board full and exclusive jurisdiction to inquire into, hear and determine any matter where it appears to the Board that circumstances may require it to act in 'the public interest'[39]. Yet nowhere in its enabling legislation is the 'public interest' defined. Because environmental impact assessments must accompany applications for facility siting and development, environmental matters must be in the public interest. As to the definition of 'environment' a review of the environmental information which must be filed suggests it includes social, economic, political and cultural impacts. Yet the role of the public in the Board's deliberations about the 'public interest' fails to meet the objectives for sound environmental decision-making. If the 'public interest' is to be determinative of the Board's decision-making then the process should include more meaningful consultation to include the negotiation among mutually-identified areas of dispute.

The model of environmental negotiation process proposed in this paper could create new access points through which the public could participate in the resolution of environmental disputes related to energy facility siting. The implementation of these proposals would be facilitated if there was public committment by the federal government to encourage the use of environmental negotiation as a dispute resolution mechanism.

The first most important stage would be the full development of this model by the Department of the Environment, including full and adequate discussion with all those persons and groups likely to be affected by the inclusion of such a process in existing regulatory and administrative proceedings. Thereafter, and presuming that full Cabinet endorsement was obtained, encouragement could be given in the form of an Environmental Policy Direction in the Speech from the Throne. Policy guidelines could be issued from the Minister of the Environment to direct bureaucratic decision-making in the selection of facilitators for environmental negotiation processes.

The National Energy Board Act and the Atomic Energy Control Act would require amendment to include preambles directing that the Boards shall, in exercising their mandates, consider 'the public interest as it relates to the protection of the environment.'

Finally the development of policies and strategies for funding to environmental interest groups would be needed.

2. Funding of Environmental Interest Groups

The inclusion of environmental negotiation processes in existing administrative procedures would increase consultation and negotiation between industry and the public adversely affected in facility site selection. In order to implement these processes successfully funding would have to be provided to the parties. There are three approaches for providing funds which could be considered:

(i) Environmental Protection Grant Programme: The federal government could create such a programme as part of an implementation strategy for a new Environmental Priority Policy. Upon the application by an environmental group direct grants could be made to it to obtain quality legal and scientific expertise. Grants for this purpose would indicate the strength of government support for meaningful participation in environmental decision-making processes.

(ii) Award of Costs by Regulatory Tribunals Under the National Energy Board Act: The Board may fix such amount as it deems reasonable in respect of actual costs reasonably incurred by any person who made representations to the Board at a 'public hearing'[40]. If environmental negotiation processes were included in the process at the points described earlier, it would be essential to broaden this provision to cover these situations too. The suggestion has been made that administrative tribunals should be given jurisdiction to award costs against a regulated industry where it is demonstrated that an environmental intervenor has demonstrated a legitimate interest in the outcome of the process and has participated in a responsible manner. This is analogous to a negative tax; presumably the intervenor has contributed valuable information and insight to the process and should therefore be rewarded. It is the opinion of the authors that such awards could only antagonize industry and to what end?

One problem with an award of costs to environmental interest groups is that it is after the fact and does not address the need for funds to prepare in advance of a presentation. In addition, groups cannot be assured that costs will be awarded in their favour, nor what the amount of the award will be. It is arguable therefore that the most effective strategy is one which would provide funds to environmental interest groups to assist with development of their presentation. Clear criteria for eligibility to such funds would be essential.

On the issue of funding for environmental interest groups, little attention has been directed to the use of legal aid plans to facilitate increased representation at public hearings in environmental disputes. In Ontario, it is within the discretion of local legal aid committees to consider applications for legal aid related to environmental hearings.

It can be argued that environmental groups have a right to legal aid assistance before a regulartory tribunal. Where a person has the right to appear at a judicial or quasi-judicial inquiry, that person is entitled to be represented by counsel[41]. Section 20 of the National Energy Board Act has been intrepreted by the Federal Court of Canada as giving every member of the public who has a demonstrable interest in the subject matter before the Board over and above the public generally the right to participate in a hearing.

While not yet proclaimed in force but as a matter of argument, Section 15 of the Canadian Charter of Rights and Freedoms states that "Every individual is equal before and under the law and has the right to the equal protection and equal benefit of the law without discrimination and, in particular, without discrimination based on mental or physical disability"[42]. Most environmental groups when pitted against industry are at a disadvantage in both 'mental' and 'physical' ability. They have inadequate resources to be entitled to the 'equal benefit of the law' because they suffer from 'discrimination' by virtue of inadequate funding mechanisms. Section 15 comes into force on April 17, 1985, it is possible that an argument along these lines will be used to obtain more adequate funding for groups with statutory rights to participate.

3. Full Disclosure of Information

In order for parties to a dispute to argue their positions effectively, they must have an adequate information base and full access to information on all the matters in issue.

The National Energy Board, in considering applications before it for certificates to construct, pipelines takes into account staff reports prior to reaching its decision. These reports are considered confidential and not available to the parties.

> "While the Board is authorized by statute to obtain information otherwise than under sanction of an oath or affirmation . . . this does not authorize it to depart from the rules of natural justice. It is clearly contrary to those rules to rely on information obtained after the hearing was completed without disclosing it to the parties and giving them an opportunity to meet it"[43].

The applicable principle in law is that each party to a hearing is entitled to be informed of, and to make representations with respect to evidence which could effect the disposition of the case[44]. While the National Energy Board argues that staff reports are confidential this has been held not to be grounds to exclude evidence from the record. Even where a statute has a provision to prevent confidential information from being made public, the parties to a statutory hearing must have a fair opportunity to answer anything contrary to their interest and a right to make submissions with respect to the material on which the tribunal proposes to base its decision. This may necessitate some editing of the material by the tribunal to protect confidentiality, but disclosure is required. This is the case unless there is something in the statute clearly pointing to the contrary[45].

Section 23 of the National Energy Board Act provides that studies and reports of the Board may be made public with the approval of the Minister. Staff reports could be disclosed pursuant to this section and would provide important and relevant information to the parties.

Under The Atomic Energy Control Act the Board receives reports from the Reactor Safety Advisory Committee. If an environmental negotiation processes were conducted at the pre-site selection stage and such reports were completed, it would be essential that they be made public as soon as possible.

Finally, there is the issue related to which parties are entitled to participate in environmental negotiation processes. All parties that are "directly" affected by a proposed development, and are seen to be in conflict, must be involved in the negotiation process. A group which has been overlooked may have recourse to undermine any negotiated settlement. It is the responsibility of the facilitator to insure that all 'affected' interests are adequately represented at the negotiating table. This issue may itself have to be a subject of negotiation and agreement early in the process.

In addition, negotiations are more likely to succeed and the agreements concluded out of them acceptable, if government representatives are parties to the negotiation process. The issues surrounding who participates are complex and require explicit consideration if an environmental negotiation process is be successful.

IV

CONCLUSIONS

The purpose of this paper has been to propose refinements to existing environmental regulatory processes to accord interest and environmental groups greater opportunity to influence the course of environmentally significant events related to energy facility siting. The proposal for a model of environmental negotiation draws upon the innovative characteristics of environmental mediation, a dispute resolution mechanism which features voluntariness, inter-party negotiation, information sharing and consensual agreement. The major features which had to be included in this proposed model were the means to facilitate consultation and negotiation among the proponents, government and the persons adversely affected by proposed facility siting, financial resources to adequately prepare and full access for all the parties to the process to all necessary information. The objectives to be achieved in presenting a model for an environmental negotiation process were the opportunity for greater equality in the bargaining positions of interest and environmental groups, the enhancement of the status of public interest intervenors, and the introduction of a process of negotiation among the parties into existing federal regulatory bodies involved in environmental decision-making processes.

Given that only a few types of environmental disputes are amenable to environmental mediation, given that most environmental decision-making in Canada is made within the context of regulatory and administrative processes, usually legalistic and adversarial in form, and recognizing that the concept of environmental mediation would introduce a voluntary, negotiated, consensual element into existing processes which currently fail to provide adequate opportunity for negotiation among the affected parties, thereby leaving many conflicts unresolved or often times creating conflict, the objective was to propose refinements which would introduce certain of the features of environmental mediation into existing regulatory and administrative processes to facilitate increased negotiation and consensual decision-making in facility siting. The authors also argued that use of the proposed model of environmental negotiation could act as a catalyst for wider acknowledgment of the value and utility of environmental mediation as a dispute resolution mechanism in environmental decision-making.

The issue which remains to be considered is can the existing regulatory and administrative processes contemplate a process of negotiation among the parties having an interest in a proposed development? In the case of the Federal Environmental Assessment and Review Process, the Minister of the Environment is responsible for final decisions about projects which have gone through the review process. Panels conduct the 'assessments' of projects which have been referred by proponents and provide recommendations to the Minister. Thus only those projects which have been referred to FEARO and then enter the assessment phase could incorporate negotiation. Because identification of the issues is a critical aspect of environmental impact assessment, the proposed model of environmental negotiation could be utilized to both identify the issues, and depending on the will of the parties, even narrow some of the issues through early negotiation. The subsequent public hearing could then address the outstanding unresolved matters.

The National Energy Board Act grants the National Energy Board full and exclusive jurisdiction to inquire into, hear and determine any matter related to disposal of energy and sources of energy within Canada and to report to the Minister of Energy Mines and Resources therein. While the Act does not contain direction to the Board to 'negotiate' any of the matters over which it has jurisdiction, clearly the powers of the

Board are sufficiently broad that the model of environmental negotiation could be incorporated as a decision-making process in the existing provisions of the Act. It would, however, require Board direction based upon its belief in the utility of negotiation to assist in its decision-making as it relates to 'the public interest'. As proposed, policy direction in the Speech from the Throne could provide the necessary impetus to the Board to include environmental negotiation at the facility siting stage.

Further section 22 of the Act provides that the Board shall recommend to the Minister "such measures ... as it considers necessary or advisable in the public interest ..." (emphasis added). The Board, itself, could initiate negotiation processes at specific decision-making points to aid in its decision-making as it relates to the 'public interest' provided it was persuaded to the value of environmental negotiation as a tool to more precisely identify the key issues, expedite the process and minimize potential environmental disputes.

The National Energy Board Act includes the concept of negotiation as it relates to the acquisition of lands. Where there is disagreement about the compensation, either party may request negotiation proceedings. Pursuant to Section 75.1, a negotiator shall be appointed by the Minister and within sixty days of the commencement of the negotiation proceedings shall report back to the Minister about the success or failure of such efforts. Clearly, the Act intends that the results of such negotiation should be taken into account in the decision-making as it relates to compensation for the acquisition of lands. It is not unreasonable therefore, to suggest that the model for environmental negotiation could be incorporated into the Board's practices for facility siting.

In the case of the Atomic Energy Control Act, the enabling legislation does not currently contemplate negotiation. Practices and procedures which have been implemented since 1977 however do indicate a trend towards greater openness. It is suggested that the decision-point at which negotiation could have considerable impact is the pre-site facility selection stage as discussed earlier.

The purpose of this paper was twofold: (1) to examine the concept of environmental mediation as a model dispute resolution mechanism and to identify those features in the process which would facilitate inter-party negotiation for environmental devision-making, and (2) to propose a process which could be integrated into exisitng federal environmental regulatory and administrative processes to facilitate negotiation among proponents, government and persons affected by energy facility siting and routing. A model for an environmental negotiation has been described to achieve this objective together with strategies for its implementation.

ENDNOTES

1. While a definition of significant will be inevitably arbitrary the following characteristics are generally included:
    - the involvement of substantial, actual or potential economic costs and benefits,
    - The inequitable distribution of costs and benefits creating a win-lose situation
    - frequent philosophical or cultural polarization paralleling the proponent, opponent views,
    - highly politicized debate at regional or national levels.
2. This definition is taken from The Environmental Assessment Act, S.O. 1980, as amended, which is the most comprehensive detailed in Canadian statutes.
3. See for example The Northern Manitoba Flood Agreement; Darlington G.S., Whitechurch; Stouffville Sanitary Landfill Site - all of which situations have been fully studied and documented by The Canadian Environmental Law Association, Toronto, Ontario.
4. Steven Shrybman, Canadian Environmental Law Association, Toronto, Ontario who has conducted considerable, in-depth research on the concept of environmental mediation and prepared a report titled "Environmental Mediation, from Theory to Practice", May, 1984.
5. F. Christof Haussmann, "Environmental Mediation. A Canadian Perspective," a report prepared for Environment Canada, March, 1982.
6. See, Cormick, Gerald, The Theory and Practice of Environmental Mediation. The Environmental Professional, 1980. Volumes I and II.
7. Shrybman, supra, f.n.4.
8. ibid.
9. Canada Royal Commission on Canada's Economic Prospects, Final Report, November, 1957. The Gordon Royal Commission appointed by the Liberal Government and the Borden Royal Commission on Energy, First Report, October 1958, Second Report, July 1959.
10. With the passage of The National Energy Board Act, the Pipe Lines Act and the Exportation of Power and Fluids and Importation of Gas Act were repealed. Gas, oil and electrical power, insofar as it was exported, were to be regulated by the new Board.

11. S.C. 1959, c. 46 as amended; consolidated as R.S.C. 1970, c. N-6.

12. Section 11(b).

13. Vanvervort, Lucinda, "Political Control of Independent Administrative Agencies", Ottawa Law Reform Commission of Canada, 1977 at p. 44.

14. In practice, decisions requiring Cabinet approval are not released until Cabinet approval is actually received. As to this relationship see, Gale, "The National Energy Board", November 1982 at pp. 16, 33-34.

15. The National Energy Board Act, supra f.n. 9 and sec. 44.

16. ibid., sec. 44 (e).

17. Gas Pipeline Regulations, C.R.C. 1978, c. 1052, as amended.

18. National Energy Board, NEB Rules of Practice and Procedure, C.R.C. 1978, c. 1057, which schedule contains provision for the filing of social impact information.

19. In considering export licenses under Section 83, the Board is given a wide discretion to "have regard to all considerations that appear to it to be relevant". However it is specifically directed to satisfy itself as to the needs of Canadians and the justness and reasonableness of the proposed export price.

20. National Energy Board Act, R.S.C. 1970, c. N-6 as amended, Section 20. The present policy of the Board is to set all "major applications" for hearing. It was held in A-G. Manitoba v. NEB, (1974) 2 F.C. (F.C.T.D.), that if a hearing is held it must be procedurally similar to that in a court of law. See Section 10 in this regard.

21. ibid., sec. 45. It has however rejected some intervenors' evidence as irrelevant. Applications for judicial review of such rejections have not met with success.

22. Gale, W., and Wolpert, M., "The National Energy Board," Paper prepared for Advanced Administrative Law, Faculty of Law, University of Ottawa, November, 1982. p. 15.

23. Sections 75.1 and 75.13.

24. S.C. 1946, c. 37 and amended R.S.C. 1952, c. 11 as amended.

25. Department of Energy, Mines and Resources, "A Brief Submitted to the Cluff Lake of Board of Inquiry", Regina, Saskatchewan April, 1977, pp. 6-7.

26. R.S.C. 1970, c. A-19.

27. P.C. 1974-1195 (May 30, 1974)

28. See "Revised Guide to the Federal Environmental Assessment Review Process" No. En 105-4/1979 (Ottawa: Supply and Services Canada, May 1979). The following description of EARP is based on R. Franson and A. Lucas, 1 Canadian Environmental Law 996-2 to 996-9 (Toronto: Butterworths, 1976 and regular service issues). See also, P. Emond, Environmental Assessment Law in Canada (Toronto: Emond-Montgomery Limited, 1978), c.5.

29. Canada, Federal Environmental Assessment Review Office, "Detailed Outline of Contents of Cabinet Memoranda Establishing the Federal Environmental Assessment and Review Process" (Ottawa: April 1, 1978).

30. The Government Organization Act, 1979, S.C. 1978-79, c. 13, s. 14.

31. Canada, Federal Environmental Assessment and Review Office, "A Guide for Environmental Screening" (Ottawa: 1978).

32. National Energy Board Rules of Practice and Procedure, C.R.C., C. 1057, ss. 6, 15, 17.

33. R.S.C. 1970, C. N-6, S.22

34. ibid, S.22(3)

35. Rules of Practice, supra, f.n. 30, S. 5.

36. The National Energy Board Act, supra, fn. 31, S. 29.2.

37. R.S.C. 1970, c. A-19

38. ibid, S.3.

39. ibid., fn. s.22.

40. ibid., s.29.6.

41. Guay v. Lafleur, (1965) S.C.R. 12.

42. The Constitution Act, 1982, Schedule B Part I s.c. 1982, c.11.

43. Pfizer Company Ltd. v Deputy Minister of National Revenue for Customs and Excise, (1977) 1 S.C.R. 456, at 463.

44. Kane v. University of British Columbia, (1980) 1 S.C.R. 1105.

45. Magnasonic Canada Ltd., v. Anti-Dumping Tribunal, (1972) F.C. 1239.

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COMPENSATION OF POWERLINE IMPACTS AS A COST-EFFECTIVE ALTERNATIVE TO RELOCATION[1]

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Abstract.—Compensation for powerline impacts may, in some cases, be a more cost-effective means of reducing net overall environmental impact than rerouting or other mitigative measures. At Lake Broadview in southern Montana, waterfowl losses due to wire strikes could have been fully offset by a recommended mitigation and compensation program costing only about 25 percent as much as line relocation. Only a partial compensation program was approved and funded; this program resulted in a partial reduction of net losses at a cost equal to 7 percent of the anticipated cost of relocation. At Rock Creek in western Montana, compensation of losses to a nationally significant recreation area was found to cost less than 41 percent of the anticipated cost of relocation. Compensation of off-right-of-way impacts may offer a cheaper and more effective solution to certain other siting conflicts than line relocation.

INTRODUCTION

One important goal of regulatory agencies in reviewing plans for proposed transmission facilities is to minimize overall environmental impact. Another important goal is to minimize project costs. Meeting both objectives simultaneously is often very difficult, and requires that all feasible solutions be seriously considered in the planning process.

Although rerouting is only one of several ways in which the overall impact of linear facilities (such as transmission lines and pipelines) can be reduced, it is the option that commonly receives the most attention in environmental assessments. Other means of reducing net impacts, including compensation for unmitigable impacts, are seldom considered, even though they may prove to be far more cost-effective than rerouting. In fact, although compensation for impacts to private property within the right-of-way (ROW) is standard practice, compensation for impacts to private individuals off the ROW—or for any impacts to public resources, whether on- or off-ROW—is often dismissed out of hand in reviewing solutions to linear siting conflicts.

This paper describes two recent cases, each involving a double-circuit 500 kV powerline crossing Montana, where compensation offered a more cost-effective means of dealing with powerline impacts than rerouting. The first case is an example of how powerline-caused losses to a "fungible" public resource (in this case, ducks) can be offset by in-kind compensation: ducks for ducks. The second case describes how powerline-caused damage to a unique public resource was offset by out-of-kind compensation: losses were offset by providing for the acquisition of adjacent areas offering substitute opportunities for public recreation. Some topics for future research are suggested in the concluding section.

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DEFINITIONS

Mitigation

In this paper, mitigation is defined as any action that reduces or ameliorates the severity of a potential impact. In some cases, it may be possible to fully mitigate an impact so that there is no change in resource quality or quantity as a result of the facility (Thompson 1979). This may be accomplished by rerouting to avoid the impact altogether, or by not building the facility at all.

Unfortunately, the costs of fully mitigating an impact are often excessive, especially at the margin: it may cost as much to reduce an impact from 10% to 0% as it does to reduce an impact from 100% to 10%. Therefore, reliance on mitigation alone can result both in excessive costs and in unacceptable "residual" or unmitigable impacts—external project costs that are passed on to the public at large.

Rerouting can be considered a form of mitigation. Many types of powerline impacts can be reduced by moving the facility away from the problem. Unfortunately, this often means moving the line closer to another problem. Therefore, full mitigation of powerline impacts by rerouting is seldom possible.

Compensation

Compensation may be defined as any action that provides substitute resources or environments to replace those lost due to a project. This definition is similar to that adopted by the Council of Environmental Quality (40 CFR 1508.20), although the CEQ defines compensation as a subset of mitigation. The reasons for making a distinction between mitigation and compensation are discussed by Thompson (1979).

It is important to realize that, while it may eliminate the net impact, compensation does not prevent impact altogether: the impact at one location is accepted, but it is offset by enhancement in another area. The situation over time has been changed, although the net losses over the long term have been eliminated.

Compensation works best with fungible resources—that is, commodities (such as grain, timber, electricity, or money) of the type in which one unit is equivalent to every other unit. Compensation does not work as well for unique resources—although, as we will see in Case 2 below, it is possible in certain cases to compensate for losses to more or less unique resources. Also, in-kind compensation (substitution of like resources) is easier to deal with conceptually than out-of-kind compensation (substitution of unlike resources, e.g. fishing access sites for wildlife losses).

Compensation of unmitigated impacts is routinely used as a tool to correct losses caused by hydroelectric development, power plant construction, and other developments for which impacts are easily quantified in terms of acreages inundated or destroyed. Indeed, compensation of such impacts has become a standard means of reducing net impacts and is supported by ample precedent and a substantial body of literature (Schwiebert 1977; Swanson 1979; Northwest Power Planning Council 1983).

Strangely enough, the concept of compensation has rarely been applied to powerline siting problems. Part of this is probably due to the fact that powerline impacts are extremely difficult to quantify—they are spread in a linear fashion over a very large area and are often experienced as a sum of small, difficult-to-measure impacts rather than a large, localized, easily quantified impact. Also, the public resources most severly affected by transmission lines—visual, recreational, and wildlife resources—are those which are by their very nature difficult to quantify. Therefore, severe transmission line related losses to these public resources are very frequently written off as unmitigable because they are unquantifiable, and the general public is left to bear the burden of their cost.

An important feature of both mitigation and compensation is this: if their costs are borne by the utility, they are no longer passed on to the general public but to that subset of the public that benefits from the construction of the facility. In economic jargon, one may say that mitigation and compensation are ways to "internalize" external costs.

Public vs. Private Resources

A fundamental distinction can be made between compensation of losses to public values, such as wildlife and recreation, and compensation of losses to private property, such as land, crops, and fences. Another important distinction can be drawn between compensation of losses occurring on the right-of-way (ROW), where just compensation for damage is clearly required by law, and that of losses occurring off the ROW. The various possibilities are shown in figure 1.

	ON-ROW	OFF-ROW
Losses to Public Resources	CASE I	CASE II
Losses to Private Resources	STANDARD PRACTISE	SEE DISCUSSION

Figure 1. Types of compensation discussed in this paper.

Compensation of damage to private resources within the ROW (figure 1) is standard practice. If private property is crossed by a ROW and the use of the land is impaired or its market value is reduced, the landowner is compensated monetarily (out-of-kind compensation) as a fair settlement for his losses. Private property that is inadvertently damaged during powerline construction—grainfields compacted by vehicles, gates or fences destroyed by construction machinery, irrigation systems disrupted—is likewise routinely compensated for to make the property owner "whole."

The other situations shown in figure 1 have not yet gained wide acceptance, although as acceptable solutions they appear no less justified, as I hope to demonstrate in the following discussion. Case I, described below, is an example of compensation for on-ROW losses to wildlife, a public resource (figure 1). Case II is an example of compensation for off-ROW losses to public recreational opportunity. In the discussion that follows I hope to demonstrate the desirability of a mechanism to compensate for off-ROW impacts to private property and amenities. In all cases, compensation of unmitigable impacts may not only be cheaper than partial mitigation or line relocation, but may also be more effective in reducing external costs to the general public.

CASE HISTORY I:
WIRE STRIKES AT LAKE BROADVIEW

History

In 1973, the Montana Power Company (MPC) and the Puget Sound Power and Light Company filed an application with the Montana Department of Natural Resources and Conservation (DNRC) for permission to construct a 230 kV transmission line from a power plant at Colstrip to a substation site at Broadview, Montana. This line was intended to transport power produced by Colstrip Units 1 and 2 to the applicants' electrical grid system.

During its environmental review, DNRC found that the applicant's preferred route crossed a closed basin called Comanche Basin in which extensive intermittent wetlands are generated during wet years and that is used by large numbers of waterfowl when flooded. The EIS discussed the possibility of wire strikes by waterfowl and summarized the available literature. In its draft EIS, DNRC identified an alternative route that passed south of the applicant's preferred route and avoided the Comanche Basin.

During public hearings on the EIS, strong local opposition was voiced concerning the DNRC route, which passed near some residential areas on the outskirts of Billings. The Board of Natural Resources and Conservation (BNRC) eventually approved the applicant's preferred route in response to this strong public opposition.

Since it was possible that the 230 kV line would eventually become part of a twin 500 kV system, BNRC granted the applicant permission to build the 230 kV line on 500 kV steel lattice towers and to string two 230 kV circuits on the towers. The conductors could later be rebundled to allow transmission at 500 kV. Most of the line was to be constructed using guyed towers. The line between Colstrip and Broadview was constructed in 1975 and 1976, a time when Comanche Basin was completely dry—as it had been for many years.

In 1976 the Colstrip-Hot Springs twin 500 kV transmission lines were approved by BNRC along the Applicants' preferred route, a two-mile-wide corridor that followed the Colstrip-Broadview 230 kV line as far west as Broadview. A centerline closely paralleling that of the Colstrip-Broadview 230 kV line was approved by BNRC in February 1978. At that time the basin was still dry. The existing conductors for the 230 kV line were to be rebundled to create the 500 kV "A" line, and a new "B" line was to be constructed immediately to the north of the existing towers.

The winter of 1977-78 was severe, with heavy snow accumulation in the basin. This severe winter was followed by an unusually wet spring, with rainfall amounts much higher than normal. As a result, the Comanche Basin filled with water in 1978, creating a lake with a surface area of about 10,000 acres and containing about 20,500 acre-feet of water. This lake was called Lake Broadview. Water remained in the basin through 1978. Winter and spring conditions in 1978-79 were similar to those of the previous winter, and in spring of 1979 the surface area of the lake was again about 10,000 acres (see figure 2).

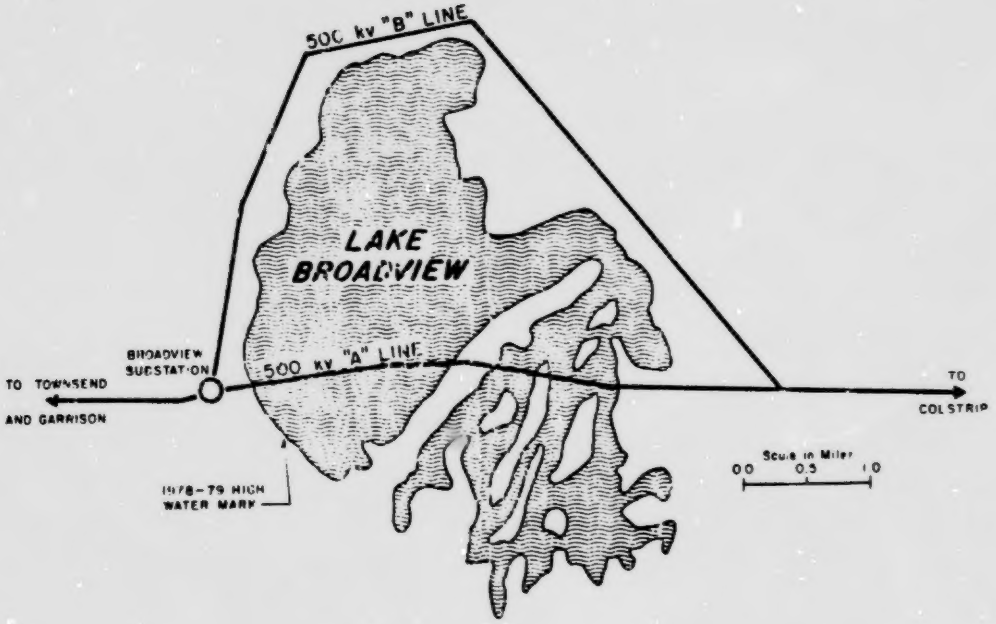

Figure 2. Location of 500 kV "A" and "B" lines in relation to Lake Broadview.

The abnormally high water levels in the Comanche Basin created a number of problems. In April 1978, large ice rafts, propelled by wind across the lake, destroyed three towers surrounded by the water. To prevent such damage from reoccurring, protective wooden pilings were installed around the towers. Also, waterfowl and other water birds—probably as many as 60,000 per year—used the newly-flooded lake habitats. Large numbers of these birds were killed by naturally-occurring outbreaks of avian botulism in 1978 and 1979, and the U.S. Fish and Wildlife Service (USFWS) responded with an intensive effort to clean up the dead birds. During the cleanup, examination of carcasses with obvious external injuries revealed that many birds were being killed by colliding with the wires of the 230 kV line.

In the spring of 1980 the surface area of Lake Broadview decreased to about 3,500 acres (5,250 acre-feet), but the area was still used by large numbers of water birds. Because of the large waterfowl losses during the summers of 1978 and 1979, USFWS began a monitoring program in the spring of 1980 to document bird mortality resulting from wire strikes. Costs of the USFWS cleanup and monitoring studies were $29,000 in 1979 and about $30,000 in 1980. DNRC was informed of USFWS concerns about these problems in August of 1980.

In August 1980, the applicants applied to BNRC for an amended certificate allowing relocation of the centerline of the 500 kV "B" line to avoid Lake Broadview (figure 2). That amendment was approved by the BNRC in September 1980 with the condition that the applicants establish an ad hoc committee, including representatives of the Montana Power Company, USFWS, DNRC, and Montana Department of Fish, Wildlife, and Parks (MDFWP), to "determine the most appropriate means of correcting or compensating for damage, if any, to waterfowl populations caused by the project in the vicinity of Lake Broadview. This committee is to present to the Board by January 1, 1981, its findings and recommended corrective or compensating measures, including a timetable and complete budget, if any, for Board approval, rejection, implementation or other necessary and appropriate action."

The Lake Broadview Mitigation Committee was thus created, and began a detailed study of the wire strike problem and possible solutions, including moving the "A" line, other mitigative measures, and compensation. In its reports to BNRC, the committee presented the findings and recommendations summarized below.

Estimates of Wire Strike Losses

Based on the USFWS cleanup data, the Committee estimated that 4,970 birds (half of which, or 2,485, were ducks) were killed each year during 1978-79 by colliding with the conductors, static wires, guy wires, or towers of the "A" line at Lake Broadview. In 1980 losses were estimated as 3,072 birds (1,536 ducks). These losses represent a bird collision rate of 4.8 birds per kilometer-day, by far the highest collision rate ever reported. The projected collision rate for the yet-to-be-constructed "B" line, which was to be located on dry land but adjacent to Lake Broadview, was estimated at 0.03 to 0.30 ducks/km-day, based on literature and other available sources.

To derive an estimate of long-term losses at Lake Broadview, the Committee had to estimate the frequency of flooding of Comanche Basin. The USFWS estimated, based on interviews with local landowners and on 1909 through 1979 precipitation data, that there has been substantial water in the basin an average of three years out of ten since 1909. Of the three problem years, one would likely be a "worst-case" year with losses comparable to those incurred during 1978 and 1979. One would be an "intermediate-loss" year similar to 1980, and one would be a "low-loss" year.

The majority of the committee eventually arrived at an estimate of long-term wire strike losses at Lake Broadview of 1,150 birds (575 ducks) per year (MPC did not agree with this estimate). This estimate was based on the estimated wire strike rates for the "A" and "B" lines and on the USFWS flooding frequency estimates, and was obtained by dividing the total estimated losses over the 37-year cost-accounting life of the project by 37 years. This is the largest wire strike loss reported to date.

Botulism Losses

The wire strike losses at Lake Broadview were small in comparison to losses caused by a related problem: avian botulism. The losses due to botulism at Lake Broadview were estimated by USFWS to be 35,000 birds in 1978 and 28,000 birds in 1979 (Malcolm 1982). These losses are greater than the annual waterfowl production at any of the national wildlife refuges in Montana.

The Committee's review of the problem revealed that the wire strikes caused by the project were exacerbating the existing botulism problem at Lake Broadview. The presence of bird carcasses in the shallow, warm water throughout the spring and summer caused botulism outbreaks to occur earlier in the year than they otherwise would and to occur with increased severity. The presence of the transmission line was, therefore, contributing to a secondary bird mortality problem possibly far greater than the mortality due to the collisions themselves.

In 1978 and 1979, when botulism losses were the most severe, the USFWS cleanup program did not begin until after the botulism outbreak was well under way. In 1980 the USFWS conducted dead bird cleanup prior to the botulism outbreak. As a result, losses were reduced to an estimated 5,200 birds (Malcom 1982). This suggested that cleanup of dead birds could be effective in mitigating the project-caused increase in severity of botulism outbreaks at Lake Broadview.

Possible Solutions

The Committee examined a number of potential solutions to the wire strike problem at Lake Broadview. One obvious solution—rerouting the "A" line above the Lake Broadview high water mark—would probably be very effective in reducing both the wire strike problem and the associated botulism problem. However, the cost of relocating the line was estimated to be $2.6 million. The committee, therefore, investigated other possible solutions to see if any were equally effective and less costly.

The committee investigated possible mitigation of the wire strike problem by engineering design, including marking wires, installing strobes, or ground wire removal. None of these options seemed very promising. They were either very costly, unfeasible, or of limited effectiveness. Water management solutions, including draining or diking of the marsh, also were considered. These options, however, were prohibitively expensive and also were likely to result in a net degradation of existing waterfowl habitat.

In the end, compensation for the bird losses by improvement of habitat off-site was found to be the most cost-effective solution to the problem of bird losses due directly to collisions. These losses could be compensated by improving waterfowl production habitat elsewhere, so that each year an additional number of ducks (equal to the average annual number lost to wire strikes) would be produced. (The committee's approach dealt only with duck losses; the committee was willing to assume that improvement of duck habitat also would benefit other bird species.) Utility-funded cleanup of dead birds was felt to be a cost-effective means of mitigating the increase in botulism mortality caused by the wire strikes.

Committee Recommendations

The committee initially recommended: (1) that the applicants be required to compensate for wire strike losses incurred during the life of the project (including known losses from 1978 through 1981, as well as projected future losses) by implementing a habitat acquisition and improvement program capable of recruiting 575 additional ducks per year into the Central Montana breeding population; and (2) that the applicant fund cleanup of dead birds during years when there is water in the basin. The total costs of this strategy would be about $270,000 for habitat acquisition, enhancement, protection, and maintenance, plus about $360,000 for cleanup of dead birds ($30,000/yr for each of the estimated 12 years there would be water in the basin), for a total of about $630,000. This figure amounts to about 25 percent of the $2.6 million it would cost to relocate the line away from Lake Broadview. Therefore, this option was felt to be the most cost-effective solution.

At the request of the BNRC, the committee eventually revised part 1 of the recommendation to separate known losses incurred through 1981 from projected future losses. The committee then presented a revised recommendation calling for: (1) a compensation program capable of recruiting 200 additional ducks per year (this target figure was obtained by dividing the total waterfowl losses incurred through the period—7,400 ducks—by the 37-year cost-accounting life of the project); (2) a long-term monitoring program based on the cleanup results; and (3) additional future compensation based on the results of the monitoring studies. That is, in the event that additional wire strike losses were documented after 1981, the applicant would be required to pay for improvement of enough additional habitat to compensate for these losses.

The committee stressed the importance of compensation based on the target number of ducks rather than on a dollar amount. In no case did the Committee consider a cost or value for each individual duck.

Board Action

In August 1981, the BNRC arrived at a decision that was a compromise between the recommendations of a majority of the committee and those of the applicants. The applicants were required to create two separate funds, each in the amount of $87,000. (The figure $87,000 was derived from a preliminary estimate of the approximate costs of acquiring and improving habitat to produce an additional 200 ducks per year.) The first $87,000 fund was to be used to acquire and manage habitat to compensate for wire strike losses incurred through 1981. The second $87,000 was to be used to implement an effective mitigation program or, if no such program could be developed, to compensate for future wire strike losses at Lake Broadview. The total costs were therefore $174,000, or only 7 percent of the $2.6 million it would cost to relocate the line.

The BNRC decision did not require the applicant to pay for cleaning up dead birds at Lake Broadview, as recommended by the majority of the Committee. This means that the USFWS, a public agency, may continue to absorb the costs of cleanup during years when there is water in the lake, and the impacts of the line will be only partially offset. The effect of the line on botulism mortality will not be corrected by the applicant. There is also the possibility that USFWS may not volunteer to fund the cleanup of dead birds the next time the lake fills. As a result, there could be serious future losses to botulism exacerbated by line strikes.

Recent Developments

Since creation of the Lake Broadview Mitigation Funds, the committee has continued to function in identifying and acquiring suitable compensation lands. Compensation activities have centered on Big Lake, another closed basin about 20 miles southwest of Lake Broadview. Much of the Big Lake basin is already in public ownership, and the committee has used part of the mitigation fund to acquire additional land to be used for waterfowl enhancement. One 350-acre parcel has been acquired, and another parcel is being negotiated. Ducks Unlimited has recently identified the Big Lake area as its No. 1 priority for waterfowl habitat management in Montana. The presence of public lands brought about by the Lake Broadview fund will allow increased flexibility in management of the entire basin by DU for waterfowl production.

Lake Broadview dried completely in July 1983 for the first time since 1976. Table 1 summarizes wire strike losses through 1983.

Year	Bird Use Days (millions)	Exposure to Collision Hazard			Estimated Collision Rate (Birds/ km-Day)	Number of Documented Wire Strikes	Estimated Total No. Birds Killed	Estimated Total No. Ducks Killed
		Ave. km.	Days	km-Days				
1978	–	4.5	230	1,035	4.8	0	4,970	2,485
1979	–	4.5	230	1,035	4.8	0	4,970	2,485
1980	7.7[1]	3.2	200	640	4.8	1,861	3,072	1,536
1981	5.0[1]	3.2	200	640	4.8	1,357	3,072	1,536
1982	–	2.8	200	560	3.0	310[2]	1,680	840
1983	–	1.5	75	112	3.0	10[3]	336	168

[1] Source: Malcolm 1982
[2] June 22 – September 3 only
[3] June 13 cleanup only

Table 1. Summary of wire strike losses at Lake Broadview through July 1983.

CASE HISTORY II:
CROSSING OF ROCK CREEK BY THE BPA 500 kV GARRISON WEST LINE

History

In January 1982, Federal District Judge James Battin ruled that federal energy marketing agencies, including the Bonneville Power Administration (BPA), must comply with the substantive standards of state law. At that time, BPA was in the process of completing an environmental impact statement on a major 500 kV transmission project, which would consist of a double-circuit 500 kV line on 165- to 175-foot steel lattice towers connecting the Garrison substation site in western Montana with the Spokane area. This line will be needed to carry power from Colstrip Unit four (a coal-fired generation plant in eastern Montana) when that plant comes on line in late 1985.

DNRC subsequently began a review of the project to determine whether it was in compliance with the substantive standards of Montana's Major Facility Siting Act. A number of alternative routes were studied during the state and federal review process.

The Problem

During DNRC's review of the project, a number of siting conflicts became evident. One of the most serious of these concerned the crossing of Rock Creek, about 20 miles southeast of Missoula, by the route that was jointly identified by the state and federal teams as the preferred route for the facility (figure 3). As site-specific centerline-level study of this area progressed, a number of seemingly irreconcilable siting conflicts became apparent.

Rock Creek is a nationally-acclaimed trout stream that provides a high-quality recreational setting for Montanans and out-of-state visitors alike. Rock Creek was the first stream in Montana to be designated as a "Blue Ribbon" stream (stream of highest recreational and biological value), and today it is one of the few "Class I" (the highest value in the new classification system) streams west of the Continental Divide in Montana.

Part of the high recreational attractiveness of Rock Creek is its relatively pristine setting within a few miles of a major city. For the past two decades, state agencies and conservation groups have actively worked to preserve the stream's aesthetic, recreational, and biological quality. A former ranch called the "Valley of the Moon," which is near the proposed powerline crossing, was acquired by the U. S. Forest Service in order to preserve the natural setting and opportunities for dispersed public recreation (mainly fishing, picnicking, and enjoyment of natural surroundings).

Conservation groups felt that any powerline crossing of Rock Creek was totally unacceptable in light of the area's aesthetic importance, high recreational use, and uniqueness. This was not merely due to the potential impacts the powerline crossing would have on visual and recreational quality at the Valley of the Moon and adjacent settings—although these impacts alone were felt to be significant enough to render a powerline crossing unacceptable. It was also felt that the presence of the line at the point where most visitors leave the heavily-developed Clark Fork River Valley, with its four-lane interstate highway and commercial development, and enter the relatively pristine Rock Creek drainage would affect the recreational experience of all visitors entering via this route.

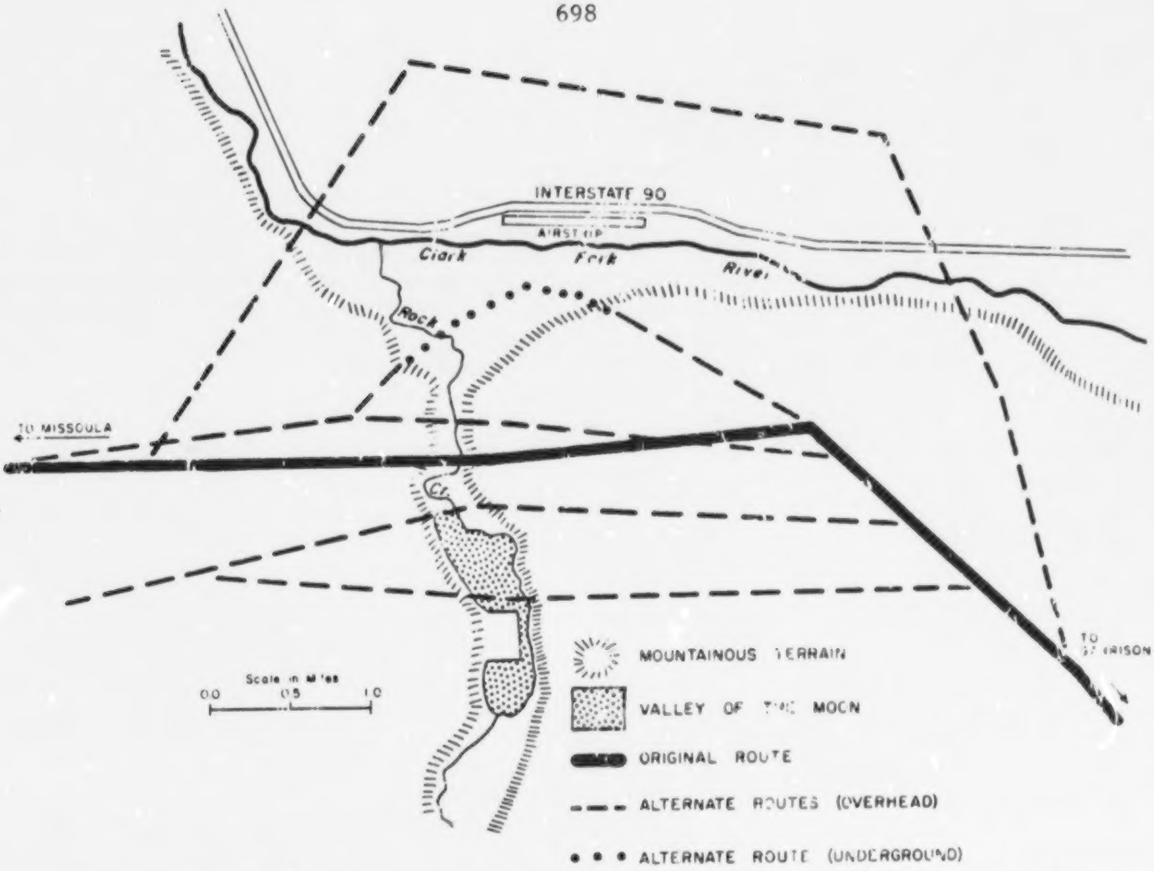
INTERSTATE 90
AIRSTRIP
Clark Fork River
Rock Cr.
TO MISSOULA
TO GARRISON
Scale in Miles
0.0
0.5
1.0
MOUNTAINOUS TERRAIN
VALLEY OF THE MOON
ORIGINAL ROUTE
ALTERNATE ROUTES (OVERHEAD)
ALTERNATE ROUTE (UNDERGROUND)

Figure 3. Original and proposed alternative routes for the 500 kV powerline crossing of Rock Creek.

According to the Montana Department of Fish, Wildlife, and Parks (MDFWP), a more significant effect of the line was the violation of the decades-old preservation agenda for the Rock Creek drainage by the powerline. It was felt that the presence of the line would erode support for any future preservation or enhancement measures in the drainage and would render any possible future protective classification of the drainage highly unlikely. Therefore, the presence of the powerline crossing near the mouth of Rock Creek could have a very real negative effect over the long term on the future management and recreational quality of the entire drainage.

A further complicating factor was the concern of the Montana Division of Aeronautics that the high Rock Creek Crossing (660 feet above the canyon floor) would pose a hazard during inclement weather to aircraft flying down the narrow Rock Creek canyon to reach an emergency airstrip along the Clark Fork River near the mouth of Rock Creek. The Division of Aeronautics took a strong position in saying that the proposed high crossing posed an unacceptable threat to pilot safety. Conservation groups took an equally strong position in saying that a lower span would be even more unacceptable than the original high span because it would require the location of a tower near the valley bottom. It seemed that there was no solution to the problem that would be even minimally acceptable to any of the parties concerned.

The RARE II issue

A separate issue concerned the crossing of several RARE (Roadless Area Review and Evaluation) II areas by the preferred route of the powerline. A 1982 decision by the U. S. Court of Appeals for the 9th Circuit prohibited any activities incompatible with wilderness in 46 California RARE II areas from taking place until the U.S. Forest Service (USFS) could prepare adequate environmental impact statements for each area. Although this decision applied only to the 46 California areas, it could set a precedent for all RARE II areas under the jurisdiction of the 9th Circuit (which includes Montana). In July 1983, three conservation groups—the West Slope Chapter of Trout Unlimited, the National Wildlife Federation, and the Montana Wildlife Federation—filed an appeal on the federal Record of Decision for the project with the chief of the U. S. Forest Service. This appeal called for a complete evaluation of the RARE II areas crossed by the BPA line before construction on the line could begin. The conservation groups also argued that BPA did not adequately consider all available alternatives. The Forest Service granted a stay for the appeals, which meant that construction of the line could have been delayed long beyond its scheduled completion date of October 1985. Any delay of the transmission project after the scheduled start-up date for Colstrip Unit four would result in cost increases to the applicants of up to $19 million per month (DNRC 1982, p. 55).

Alternatives to the Rock Creek crossing

DNRC, in its study of the Rock Creek siting problem, looked at a number of possible alternatives to the controversial high and low spans (figure 3). These included underground construction of the lines across the mouth of Rock Creek, routes which would cross Rock Creek farther upstream, and a route which would avoid crossing of Rock Creek by crossing the Clark Fork River twice (via either underground or overhead construction). All of these options would have increased the costs of the project greatly (by amounts ranging from $4 million to $13 million), but would not have substantially reduced the overall impacts of the project. Those options that would have avoided crossing Rock Creek or that would have reduced the hazard to aircraft would have created severe land use or visual impacts in the Clark Fork Valley. Such impacts would have proven unacceptable to other groups. The underground options would have done little to reduce overall visual impacts and would have created a host of new problems, including severe engineering and geotechnical problems.

DNRC, therefore, attempted to identify other solutions that could reduce net evironmental impacts to an acceptable level at a lower cost than the options mentioned above. In all, fifteen separate options were studied.

The solution which seemed to have the most merit was the compensation option. This would involve crossing Rock Creek along BPA's originally proposed alignment, but then compensating for the primary unmitigable impacts of the crossing. These impacts include visual and recreational damage to the Valley of the Moon and to the entrance to the Rock Creek canyon, a decreased likelihood that protection of the valley could be achieved in the future by special designation or classification, and the broader impact of negating the decades-old conservation agenda. It was felt that these impacts could be compensated for by acquiring protective easements on private inholdings farther upstream in the Rock Creek drainage.

Although a cost for this option could not be calculated, DNRC staff felt that adequate compensation could probably be achieved at a much lower cost than would have to be paid for any of the other options. The U. S. Forest Service and a private consultant had already been actively seeking options on selected parcels in the area (none were purchased because funds were cut off), so prime parcels for recreation enhancement were readily available.

Still, some mechanism was needed to determine the amount of compensation that would be needed. In this regard two major possibilities were discussed. First, an extensive study of Rock Creek could be conducted after the line was built to determine quantitatively the extent of recreational and visual impacts due to the project. The results of this study could be used as the basis for formulating a compensation package. This approach was not favored because of the difficulty of quantifying recreational and aesthetic impacts, the likelihood of delay in any settlement until years after the project is built, and the fact that the results of any such studies could be argued indefinitely without resolution—possibly with the result that no compensation would ever actually be achieved. Second, a dollar settlement could be negotiated. A problem with this latter approach is that it is not quantitatively linked to actual documented impacts. O'Hare et al. (1983), however, suggest that "compensation is best determined through negotiation among the parties to a dispute."

In the end, DNRC recommended the compensation option to the BNRC as the most cost-effective solution to the problem, and the only solution that would be even marginally acceptable to all parties involved. In spite of its drawbacks, negotiation of a compensation package without quantitative documentation of impacts seemed to be the only feasible way of arriving at an equitable settlement. It was felt that aeronautical hazards could be adequately mitigated by pilot education, posting of warnings at nearby airports, and marking of towers and wires with strobes or marker balls.

Unfortunately, BPA was unwilling to consider the possibility of off-site compensation. BPA officials indicated that even if the BNRC approved DNRC's recommended compensation option, BPA would likely not carry it out. It seemed unlikely that negotiations for a compensation package could even be initiated with BPA. Nevertheless, DNRC carried through its recommendation to BNRC, maintaining throughout that it was the most cost-effective and reasonable solution to this siting conflict.

Meanwhile, the conservation groups which had appealed the Record of Decision for the project had independently arrived at the idea of compensation for the powerline's impact to Rock Creek as a solution. Acting independently from the DNRC and BNRC process, they began negotiating a compensation settlement with MPC, the utility that was depending on timely construction of the powerlines to carry the power of Colstrip Unit No. 4. The conservation groups stated that they would be willing to drop their appeal of the Record of Decision if the impacts at Rock Creek could be satisfactorily compensated.

The Compensation Settlement

During the final days before the scheduled meeting at which BNRC was to make its decision on the issue, the conservation groups, BPA, Montana Power Company, DNRC, and the USFS met to negotiate a compensation package. At first, BPA was not willing to even discuss the option of compensation, although the conservation groups had decided that it would be an acceptable, if imperfect, solution. BPA agreed to negotiate a settlement only after the builders of the Colstrip project had agreed to fund the program and after the conservation groups agreed to withdraw their appeal on the RARE II issue.

By the time of the BNRC meeting, a $1.65 million compensation package had been agreed to by all parties. The funds would be paid to a public agency for the purpose of securing conservation easements and/or implementing monitoring programs in the Rock Creek drainage. The conservation easements would provide long-term protection of the area from further visual degradation, and would provide for public access to additional high-quality recreation lands in the drainage. The conservation groups had agreed to withdraw their appeal of the federal Record of Decision.

BNRC arrived at a decision on the Rock Creek powerline on August 19, 1983. In this decision, the BNRC adopted DNRC's recommendation for the compensation option. In its conclusions and final determination, BNRC determined that the project would comply with the substantive standards of the Montana Major Facility Siting Act if the line were built along the original crossing and the compensation package were implemented. Since the conservation groups had already negotiated a compensation settlement, BNRC was able to specify a dollar amount for the DNRC's recommended solution: "The mitigation measures include the payment of $1.65 million to a public agency for mitigation of adverse impacts at the time the...line is substantially completed and available for transmission of power."

It is important to realize that the BNRC decision and the negotiated settlement between the conservation groups and MPC were entirely separate processes. Had the conservation groups never filed the appeal on the federal Record of Decision, BNRC could still have adopted DNRC's recommended compensation program (although a dollar amount for the compensation settlement would probably not have been specified, and BPA might have refused to comply with the BNRC requirement). The fact that the appeal was filed, however, provided impetus to the utilities to negotiate a settlement which they might otherwise have refused to consider. This contributed in no small measure to a strong public reaction to the final settlement.

Public Reaction to the Settlement

Public reaction to the compensation settlement focused on one aspect of the process: the negotiations between the utilities and the conservation groups. The fact that a parallel process—that of the DNRC and BNRC—was leading independently to the same solution seems to have been ignored. The meetings were making headlines in local newspapers during the final days of the negotiations. After the agreement was signed, a number of strongly-worded editorials appeared in the press. Opposition to the settlement seemed to be equally strong on the part of both industry and environmental interests. Some members of conservation groups called the settlement a "sellout"; some utility representatives called it "blackmail" and "extortion".

However, once the issues behind the settlement were made clear, most groups came closer to a general acceptance of the concept. Some of those who attacked the settlement realized later that DNRC independently recommended a compensation settlement, and that the BNRC could have made the same determination even without the complications of the RARE II issue and the appeal of the federal Record of Decision. The utilities involved considered the settlement " a good business decision." An editorial in "Transmission and Distribution," a major utility industry journal, went so far as to praise the solution as evidence that "environmentalists and utilities can work together," and to suggest that "utilities would be well advised to foster this attitude and approach." (Lewis 1983). A spokesperson for one of the environmental groups said, "Some people say we were totally wrong and that we gave up too early. But we didn't give up. We won. We got the best we possibly could have wanted. I don't feel we traded principles for pragmatics." (Helena Independent Record, August 23, 1983, p. 3B). A representative of Defenders of Wildlife wrote, "...the RARE II issue never offered any hope of stopping the powerlines; at best, all the conservation groups hoped to achieve was...more mitigation for key resource features. When it became clear the groups might save time and money by negotiating a settlement..., an agreement was reached. Although the powerlines will cross Rock Creek, they'll do so on the conservation groups' terms." (Missoulian, Sept. 4, 1983, p. 10)

CONCLUSIONS

Summary of Case Studies

Each of the case histories described above incorporates unique features and is far from an ideal example. Nevertheless, these case histories do, as a group, offer real examples of situations where compensation for powerline impacts has provided a more cost-effective alternative than line relocation. One case involved compensation of losses to a public resource within the ROW; the other involved compensation of off-ROW losses to public resources. As demonstrated by these case studies, compensation appears to be a valid alternative to line relocation and, in some instances, the only equitable and satisfactory solution. Based on the beneficial aspects of the compensation option, it is difficult to understand why compensation is not standard practice in powerline siting as it is with hydroelectric development.

Needs for Future Research

The case studies described above are two instances where compensation of impacts to public resources offered a more cost-effective solution to siting conflicts than rerouting. Compensation for off-ROW impacts to private property and resources (figure 1) might also provide an alternative solution to certain siting conflicts, and seems to be a promising field for further research.

Michael O'Hare of the Kennedy School of Government at Harvard University has written that "An important failing of current practice in siting an ugly or dangerous facility is the strategic problem that results from failure to pay compensation to neighbors who suffer costs (losses in property values or less measurable amenity costs) not found to be a taking under law. Unless such compensation is paid, a socially beneficial project can be stalled or blocked permanently on each possible site." (O'Hare 1977). He proposes to "compensate victims of localized [off-site] nuisance costs, just as we already compensate those who suffer tangible costs when their property is physically invaded or taken by eminent domain."

Siting of large, unsightly transmission lines is an example of the larger problem discussed by O'Hare, namely the inequity of current means of settling off-site damages for a "locally noxious facility...that seem(s) to threaten a few for the good of many..." In current practice, "...costs imposed on the few unfortunate neighbors of a major new facility, except as they were reflected in acquisition costs through condemnation, [are] for the most part ignored." O'Hare suggests that "compensation for local sufferers is not only an equitable desideratum, as has long been recognized, but a strategic necessity for aligning critical actors' interests with the public interest."

In the case of large transmission facilities, it is standard practice to compensate only those landowners whose property is actually crossed by the ROW and which is "taken" either through negotiation or through condemnation. Landowners owning property or homes immediately adjacent to a ROW, but whose property is not actually crossed by the ROW, may also suffer real damages (such as lowering of property values, despoiled views from living-room windows, degradation of locally prized scenic views, or damage to other amenities). Such people stand to lose a lot if a proposed project is built in their back yard. Yet they receive nothing in return. They do not have the opportunity to sit down and negotiate a settlement, while their neighbors whose property happens to be crossed by the project may receive a sizable monetary settlement. Also, as they may perceive the situation, the distant users at the load center receive all the benefits of the project yet bear none of the external costs. Such is the inequity.

This fundamental inequity leads to one of the primary problems of siting large transmission facilities. The only option available to off-ROW people who would be adversely affected by a proposed project is to strongly oppose the project—and to do anything in their power to stop it, delay it, or at least move it to "somebody else's block," whatever the cost. To accomplish this, these people often elevate whatever local concerns they can find—life-styles, center pivots, wildlife areas, ranching operations—to exaggerated importance in an attempt to stop the project or to move it into somebody else's back yard. Commonly, the issues raised most strongly are those that are emotive or which can be argued indefinitely without resolution—e.g., health effects. If one group succeeds in moving the line to somebody else's back yard, the "somebody else" thus affected is likely to react similarly. The outcome of such public opposition commonly falls among one of the following possibilities:

(1) local opposition will be so strong that a socially beneficial facility is stopped or delayed;

(2) the project is built through somebody's backyard, affecting them severely yet offering them no compensation whatsoever, while their peers over the ridge get off scot-free; or

(3) the project is relocated into the mountainous wilds where there are no vocal, angry residents. This, in turn, often results in increased length and construction costs, decreased reliability of service, and increased natural resource impacts. It also merely shifts the impact burden from one segment of the populace—the local landowners and residents—to another, namely those who value and use unspoiled settings, wildlife, and dispersed recreational opportunities. The costs, however, remain external, and are still borne by one or another segment of society other than that which receives the benefits of the project. Whatever the outcome, someone ends up unhappy: the process has resulted in increased costs, increased impacts, or both.

O'Hare et al. (1983) suggest that compensation offers people who suffer off-ROW impacts an alternative other than to fight the project. If this group of people could be offered compensation for the real impacts they suffer—as are their neighbors who happen to own land on the ROW—chances are they would be more willing to accept the project in their area. The costs of compensation would be diffused over a large population of electricity users and would probably not even be noticed by them. At any rate, failure to compensate for these impacts can result in increased costs far higher than those that would have resulted from even a very liberal compensation program.

In a recent siting decision involving BPA's double-circuit 500 kV transmission lines across Montana, substantial line relocations were made in response to strong public opposition. This opposition was largely based on visual impacts and impacts to residences and agricultural land. As a result of the relocations, the length of the line was increased by 8.2 miles, certain environmental impacts were increased significantly, the costs were increased by $14.7 million (not including line losses), and many of the concerns which prompted the relocation were not fully mitigated by the new alignment (DNRC 1982, 1983 a&b).

Had there existed some mechanism to compensate the communities and individuals for real losses in amenities (and for other impacts) at a cost less than $14.7 million, the outcome might have been quite different. It is likely that a compensation settlement much smaller than the costs of relocation could have been negotiated, since the combined annual budgets of the three counties crossed by the segment of line in question total only $5.5 million (Mont. Dept. Commerce, pers. comm.)

If compensation continues to be discounted as a possible alternative to relocation, similar problems can be expected to recur time and time again when needed major projects are proposed through residential areas. Compensation of local residents and/or amenity users for off-ROW impacts would seem to offer an equitable—and cheaper—solution to the problem for all concerned. The desirability of a mechanism to compensate for off-ROW impacts can be expected to increase as UHV transmission becomes more common. In fact, one study has suggested (Sforzini 1980) that UHV may never become viable unless such a mechanism is developed.

The utility industry has much to gain by developing and implementing a mechanism allowing consideration of compensation as an alternative to relocation in facility siting. Project costs could be reduced by millions and the likelihood of delay or stopping needed projects would be greatly reduced. It seems that industry, and not regulatory agencies, should take the lead in developing standards for compensatation of powerline impacts, particularly off-ROW impacts to private parties. A viable approach might be the development of industry standards and guidelines for determining when off-ROW compensation of landowners is justified and how large the settlement should be. The settlement could be based on a decreasing stepped function, since impacts generally decrease with distance from the ROW. Such a method has been proposed by O'Hare (1977), as shown in figure 4. Sforzini's "penalty factor" method is also a promising approach (Sforzini 1980). To ensure equitable settlement, the system should be designed such that the most outspoken landowners would not get favored treatment. Development of industry-wide standards would help prevent this. At present, it seems such standards are most badly needed for UHV projects (Sforzini 1980).

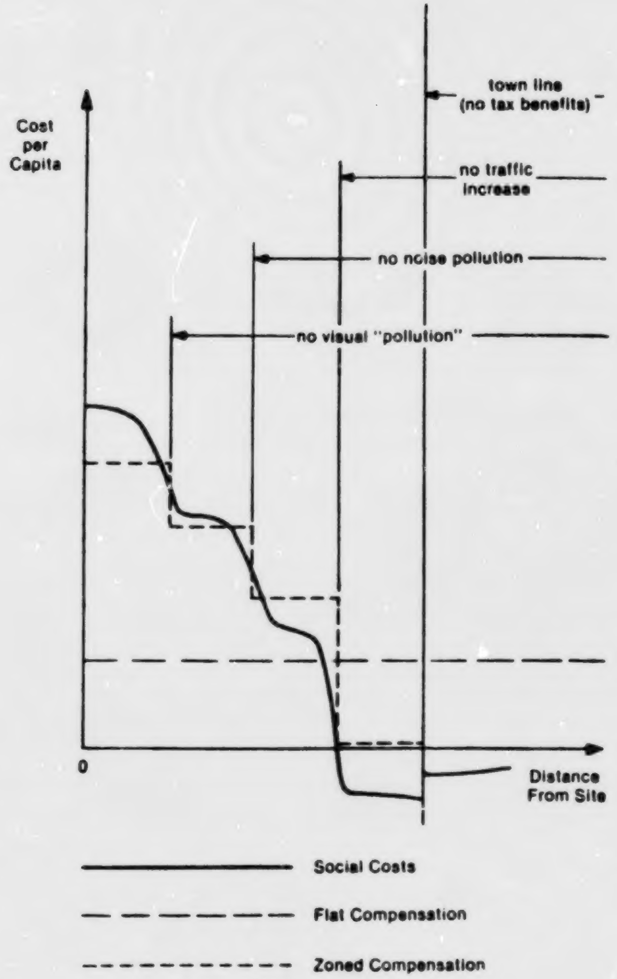

Figure 4. "Zoned compensation," or compensation based on a stepped function decreasing with distance from the ROW (reproduced with permission from O'Hare 1977).

ACKNOWLEDGEMENTS

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MEASUREMENT OF PERFORMANCE OF ROUTE/SITE SELECTION STUDIES

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ABSTRACT

With increasing pressure for economy, and "value-for-money" in government agencies, there is a consequent need to document effectiveness and efficiency in route/site studies and other environmental and land use planning projects. Based on analysis of more than thirty such studies and borrowing from other industries, a performance measurement system has been developed in terms of concept, procedures, documentation, and a computer system for storage/retrieval of information. This system can probably be adapted to most related studies, and includes guidelines on cost and methods of measurement of effectiveness and quality.

INTRODUCTION

With the present state of the economy, public demands for government accountability, and new concepts such as operational (value for money) auditing, many organizations in the fields of route and site selection, land use planning, natural resources, and environmental assessment are under growing pressure to improve and report on performance and productivity. A common reaction is that it is not feasible to systematically monitor and report on performance of a planning office, since the nature of the work is much less tangible than that of say a car assembly line. However, by borrowing concepts from industry, and adapting them to processes common to many planning and scientific research projects, a performance measurement system has been developed and implemented in a large planning office. This approach could likely be applied in other planning offices and related disciplines with minor modifications.

The key requirements of a performance monitoring system are:

Informativeness: It should be comprehensive enough to reflect all aspects of the work, and all types of work. Information that truly indicates performance is obviously essential, yet often considerable thought has to be given to ensure that this is actually achieved.

Cost Effectiveness: Since a major motive for performance monitoring is concern about costs and productivity, the monitoring system itself needs to be seen to be setting an example. Clearly, measurements and reports that are not very revealing about performance and those that are time-consuming should be carefully evaluated. To save costs, some measures can be devised to give insights to several aspects of the work that are not worth separating, or else that can be separated by inference. Overall, the system must show a positive benefit/cost ratio, with relatively little incremental cost.

Appropriateness: The system must fit the type of work being done in the office, and if necessary, must be flexible enough to adjust to related but somewhat different work as functions change over the years.

Compatibility: Unless current work control methods are chaotic, it would be counter-productive to disrupt them and introduce totally new management concepts. The system should preferably be one that can be grafted onto existing supervisory and management procedures, or perhaps even streamline them. The format needs to be adaptable to existing organization structure (teams, sections, departments, etc), the different types of work going on, and any existing recording and reporting systems.

Confidentiality: Although there should be good information flow between a subordinate and his superior, privacy between peers can be very important, especially in a competitive career situation. Generally, this tends to be controlled by the superior for work done by his/her immediate subordinates, and this should be a conscious responsibility for his/her office. The system itself should provide full confidentiality. Also, lack of confidentiality arouses serious antagonism to the introduction of a system. In addition to internal confidentiality, the company as a whole may wish to keep its detailed records private and publish overall reports (often for fear of misinterpretation of raw data rather than a desire to 'cover up').

Acceptability: The philosophy, manner of implementation, and practical techniques must be designed so as to find acceptance from the people involved.

DESIGN CONCEPT

A large number of performance measurement concepts and systems have been available for several decades at least, mostly in sales and manufacturing-oriented companies. All are based primarily on the concept of setting a target (objective) and checking up on how well it is achieved. The problem is to adapt the idea to a planning office in such a way that the philosophy and practice meet the key requirements suggested above.

A major difference between a planning office and sales or manufacturing organizations is the nature of the work and the products. Sales offices and factories are usually involved in repetitive work that is simple in concept (though techniques and individual cases can be very complex and challenging) and has easily measurable results (e.g. total dollar sales or number of widgets per day). Performance monitoring systems for the latter can thus be devised with relatively few, and fully quantitative, measures. Some common systems developed originally for those situations, MBO (Management by Objectives) and MAR (Management by Achievement of Results) do not adapt well to a planning office, where much of the work is of a 'one-off' nature more closely akin to research and development, where many important aspects are qualitative, and where the professional mentality is different and people tend to resent a mechanistic type of control.

A voluntary response survey of planners in Ontario Hydro showed that most of them consider themselves to be highly personally motivated, and they cited the main causes of poor performance to be either uncertainty over the nature of the product required, unreasonable demands on them without negotiation, and external unforeseen circumstances (e.g. public opposition). This is consistent with the findings of other studies and companies (e.g. (1)). In effect, it means that much of perceived poor performance is really the lack of a well defined scope of study and mutual agreement on terms of reference. Further, if these can be simply and tightly defined, the residual poor performance of a person or organizational unit will become very clear, and can be dealt with. Therefore, the basic approach recommended for a route/site planning office may be described as 'Management by Integration of Expectations'. Under this approach, a series of topics (measures) are established to describe the nature of the work, and then the producing unit and the client communicate their expectations and neogtiate an agreement on each one. This terminology and philosophy was found to be much more acceptable to planners than hardline approaches such as MBO and MAR.

The next step is to identify what measures should be discussed and defined to fully represent route/site planning work. These generally fall into two categories: effectiveness, which expresses whether or not and how well the product is achieved; and efficiency, which expresses various forms of cost and effort involved in production. Based on debate and refinement over two years among some 30 planners, the measures shown in Figure 1 are recommended. These are considered appropriate for offices engaged in route/site selection, environmental impact assessment, natural resource survey or planning, and regional or town planning. They could likely be adapted to related fields with minor modifications.

One important point to note is that it is necessary to use all of these measures in order to gain a full and fair picture of expectations and performance in planning. For example, one study may be more costly than historic average because the quality was designed to be higher than usual, or because conscious effort was made to 'overdo' the quantity of work to help restore credibility. Unless each of the topics underlined is reported on, it becomes difficult to explain performance. A second point is that Figure 1 deliberately avoids weighting the various measures, since each company or office would naturally have different weights, and should make them clear in advance to its staff.

To be definitive both when setting expectations and recording achievements, these measures need to be applied to some entity. That entity should be as tangible as possible, sharply defined, and readily identifiable to all concerned. For example, it is possible to define each route/site planning task as an individual project, and regard the plan or report as the tangible product and the date of its completion can be readily identified.

The next thought is that it is highly desirable when monitoring and managing improvement of performance to have progress reports, and to provide opportunity to improve performance before completion of a project. This leads to the idea of breaking up each planning project into smaller yet still discrete steps, each of which is clearly completed at a specific point in time with a tangible product or milestone event. Identification of steps and milestones can be unique to each planning project, and probably would be for innovative or development studies. However, by extensive literature review of route/site studies, land use planning, and scientific research methods, we have found sufficient consistency to adopt some standard steps that are generally applicable to most of our planning work (Figure 2). Using standardized steps does not seem to intrude on planners' choices of methods and techniques, and has a great advantage in allowing cross-referencing of performance by steps (e.g. to identify costs of environmental mapping).

The final conceptual consideration is that of a recording system. As explained to this point, that comprises a separate file for each planning project or task. Each project is broken down into a useful number of steps (often about 8), and a list of measures is applied to each step. This yields a matrix, as shown in Figure 3, of steps and measures for each project. For each matrix box (Step/Measure) it is necessary to record the expectation and the achievement. The expectation may be set at the beginning of the project, or at the beginning of the step, and the achievement is recorded at completion of the step. It is also desirable to record explanations of variance (good or bad) from the expectation. If misused these become merely excuses, but properly used they are extremely helpful in identifying consistent or persistent problems affecting the organization.

MEASURES

The measures shown in Figure 1 cover a wide range from fully quantifiable to purely qualitative, and at first there could be considerable scepticism about measuring and recording quality in a field such as route/site selection. There are of course plenty of procedures developed in the field of quality engineering for doing so, even in older basic text books (2), let alone more advanced or modern ones (3). So it is generally possible to develop meaningful measures of quality.

For the purpose of performance reporting, comparison with previous products or peer groups is most important, and this is much easier than absolute measurement. Some examples of measures, covering a wide range of types are given below:

Cost

This could be measured in terms of dollars, however, it is recommended that manhours are better measurement units. Manhours are more universally comparable, since dollar costs vary in time and among organizations. The disadvantage with manhours is that cash expenditures cannot be included (e.g. purchase of services, supplies, expenses), but our experience has been that these are a small and usually consistent percentage of salary costs in a route/site planning office.

Timeliness

This reflects ability to meet schedules, so the measurement units are in terms of calendar time, not manhours. A recommended way of doing this is to fix the expected date of completion, then count back to the start date to record the number of workable days ("calendar working days"), and likewise count forwards from start to actual finish date to measure the achievement.

Work Quantity

This is harder than cost and timeliness to quantify, however with positive intent it can be done. Different steps may lend themselves to very different measurement units. For example, environmental mapping effort tends to correlate with the number of map sheets involved and the variable being mapped, i.e. regardless of scale, and for a given quality of mapping.

It is best to subdivide mapping into 'level of effort' categories such as 1) soil or ecosystem mapping (high fieldwork content), 2) forest inventory (complex air photo interpretation), 3) land use mapping (simple air photo interpretation). As another example, one can record the number of alternative plans or sites evaluated. Often, measurement units will be crude, however it is stressed that even rough estimates can be very valuable information. We feel our project management has been greatly improved even where we cannot do better than estimate into one of three levels of effort 'high, medium, and low', provided these levels are defined and documented to help consistency.

Work Quality

Measurement 'units' for quality are likely to vary greatly among different types of work and steps. The easiest basis for quality estimating is by comparison with class examples. In the case of report writing, a panel of experienced staff can be asked to select example reports that are considered to be of appropriate quality, plus some representing qualities distinctly above and below that level (perhaps even five classes total). A particular product can then be rated according to which of these it most closely resembles. In the case of environmental mapping, there is a growing trend towards quantification of quality considerations such as accuracy (4).

Two important considerations when establishing measurement units are 1) to ensure that the measure is a meaningful expression of performance and 2) to take advantage of existing recording systems as much as possible (e.g. accounting systems for costs). In some cases, there may be no suitable measurement unit for a particular measure/step, or it may not be worthwhile, in which case the record can be left blank without upsetting the system.

STANDARD TARGETS

Each recorded expectation is in effect a target or objective to be achieved, and performance is measured by the degree of variance that is attributed to the staff unit (team, section, etc) rather than to circumstances beyond their control. Where work is at least somewhat repetitive, it seems reasonable to expect that in time the skills in setting expectations and in meeting them would improve until achievements were consistently close to (100% of) expectations. However, some new staff units may need to evolve up to that level, or else a manager may raise the expectations so as to raise productivity, quality, etc. Under any of these circumstances, it is possible to create a class of targets that are consistent expectations among various staff units and over time. These can be referred to as standard targets, and are a very valuable management tool.

It is particularly valuable in the present economic climate to be able to compare performance between peer groups, whether within the organization or in other companies. This is not often possible in terms of a complete project. The advantage of a step/measure approach is that it is often more feasible to find reasonable comparisons at the 'step' level of detail. The comparison may well be only in 'ball park' terms, but that can be valuable enough. For example, although few companies in the world have to follow the same process for environmental assessment that we do, many different companies and agencies do the same kinds of environmental mapping, so we are able to compare performance at least on that element of the work.

COMPUTER SYSTEM

It is evident from Figure 3, which shows only some of the information required for one project, that considerable quantities of performance information will be generated in a large office. Many of the data are numerical, and all of the other information can be reduced to code letters or acronyms. This suggests that a computer can be very useful to store and retrieve data. The main benefit of having computer assistance, however, is its speed and its capability for cross-referencing within a complex matrix such as Figure 3. It is often desirable for managers to analyze historic trends, compare staff units, or trace single measures and projects across a number of staff units. Raw data may need to be reproduced in graphical form as well.

Based on these considerations, and given that the planning office involved has some 120 people in some 20 different work units, a computer system was developed to handle the storage, retrieval, and analysis. Initially, there was considerable fear and antagonism from supervisors towards the idea of storing sensitive performance information on the company's mainframe despite assurances about confidential access codes and passwords. This problem was overcome by agreeing to use a desk top computer with removeable floppy discs. Records of a particular staff unit's performance can thus be physically held by the supervisor and his immediate manager. Other people who have a right to access the records would have to let the supervisor know when they wanted to do so. This idea of physical possession of a tangible record seems to eliminate most of the concern about the use of a computer system.

Most medium-priced desk top computers ($5,000-$7,000) with spreadsheet software have sufficient capacity to handle the system.

CONCLUSIONS, BENEFITS, AND COSTS

Introduction of a systematic approach to performance monitoring and reporting, especially the concept of milestone events, has proven acceptable and very beneficial. Responses indicate that the 'management by integration of expectations' concept is just as valuable for the planning of work (e.g. budget estimating) as it is for performance control. It is also now distinctly easier to explain to senior management why certain costs vary from normal, and to demonstrate increasing external pressures for higher quality and credibility. One spin-off benefit has been to improve the familiarity of some planners with computers.

The total cost of developing the concept and designing the system to date is approximately $85,000 (1983 dollars) plus about $5,000 for the computer and accessories. It is estimated that a further $25,000 will be needed to finalize implementation. Operating costs are estimated to be one-third of the time of a technical supervisor to maintain interest in the system and solve problems, one-half the time of a data entry clerk, and a few hundred dollars per year for forms and computer supplies (i.e. about 0.7% of total office budget). The principal problems experienced to date are in maintaining interest and use until the system 'becomes a habit' and in checking to ensure that correct codes are used until these are memorized. Supervisors could potentially spend a lot of time inputting and retrieving information, however this is not recorded as a cost on the grounds that it is replacing the previous less systematic supervisory activities, i.e. there is no cause for incremental cost for supervisors or managers apart from some minor familiarization.

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PERFORMANCE

EFFECTIVENESS

APPROVAL INDEX

TIMELINESS

QUALITY

CREDIBILITY

CORRECTNESS OF ASSUMPTIONS

ORGANIZATION EFFECTIVENESS

SPINOFFS

EFFICIENCY

EXPENDITURE

QUANTITY OF WORK

QUANTITY OF RESULTS

EXPERTISE

STAFF NUMBERS

DATABASE

MORALE/HEALTH

ORGANIZATION EFFICIENCY

FIGURE 1

EXAMPLES OF MEASUREMENT TOPICS

A. ROUTE/SITE SELECTION, ENVIRONMENTAL ASSESSMENT OR NATURAL RESOURCE PLANNING

1. Scope/Study Design
* 2. Analysis of significant issues/impacts/resources
* 3. Mapping of significant impacts/resources
* 4. Identification of alternative plans/sites/methods
5. Evaluation of alternatives
6. Comparison/selection
* 7. Report preparation
8. Approval/publication/public hearings
9. Follow-up/monitoring

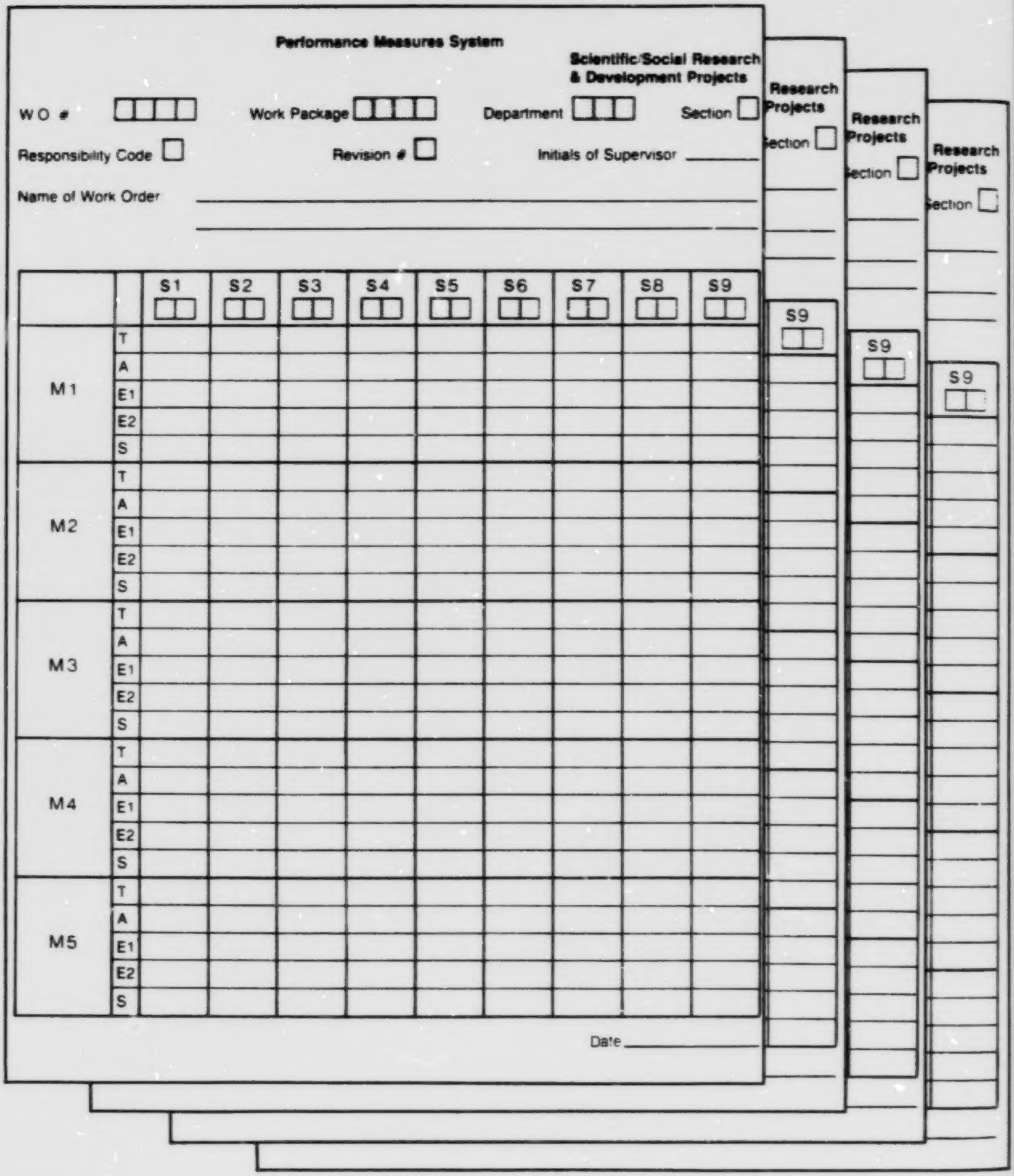
B. SCIENTIFIC/SOCIAL RESEARCH, DEVELOPMENT STUDIES

1. Scope/Study Design
* 2. Literature review/published data review
* 3. Original observations/new data collection
* 4. Development of alternative hypotheses/solutions
5. Evaluation of alternatives
6. Comparison of alternatives/selection
* 7. Report preparation
8. Approval/publication
9. Monitoring/feedback/follow-up

* Work on each step is discrete but may occur simultaneously with other steps.

FIGURE 2

SUGGESTED STEPS FOR PLANNING OFFICES



Performance Measures System

Scientific/Social Research & Development Projects

WO # ☐☐☐☐ Work Package ☐☐☐☐ Department ☐☐☐ Section ☐

Responsibility Code ☐ Revision # ☐ Initials of Supervisor ________

Name of Work Order ________________________________

		S1 ☐☐	S2 ☐☐	S3 ☐☐	S4 ☐☐	S5 ☐☐	S6 ☐☐	S7 ☐☐	S8 ☐☐	S9 ☐☐
M1	T									
	A									
	E1									
	E2									
	S									
M2	T									
	A									
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M3	T									
	A									
	E1									
	E2									
	S									
M4	T									
	A									
	E1									
	E2									
	S									
M5	T									
	A									
	E1									
	E2									
	S									

Date ________

Research Projects

Section ☐

S9 ☐☐

Research Projects

Section ☐

S9 ☐☐

Research Projects

Section ☐

S9 ☐☐

Figure 3 Raw Data Record Format

Using Mediation To Resolve Energy-Environment Conflicts

Poster Session: Facility and Routing '84
Energy and Environment

April 15-18, 1984
Banff, Alberta

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Abstract

Using Mediation to Resolve Energy-Environment Conflicts

New techniques were developed in the United States in the early 70's that sought to help resolve complex environmental conflicts. One such technique that was adapted from the Labour-Management arena, is mediation. Mediation is a voluntary process where parties agree to jointly explore their differences with the help of a neutral third party. The paper describes the process of mediation and its use in both a Canadian and American environmental dispute, involving energy related activities. Brief comments are provided on mediation and its potential use in regulatory proceedings and an account of research initiatives on environmental mediation in the Canadian context is included.

Using Mediation to Resolve Energy-Environment Conflicts

Introduction

One of the most wide spread and pressing problems facing many countries today is that of energy security. As conventional and assured reserves of hydrocarbons are depleted, increased pressure is exerted to find and exploit existing energy stores and to develope new and varied methods to utilize renewable and non-renewable energy sources. As Gladwin (1980) points out, this action gives rise to a variety of disputes that can be catagorized into several broader issues of contention: job creation vs. clean air, growth vs. no-growth, risks vs. costs, technocracy vs. democracy, national vs. local interests, hypotheses vs. facts, politics vs. science, equity vs. efficiency, exploitation vs. preservation, short term vs. long term, life vs. death, and so on.[1]

Canada is no exception to countries experiencing disputes over energy development. Canada's reaction to price increases of foreign oil supplies in the early 1970's prompted a flurry of activity designed to promote energy conservation and at the same time to make better and more extensive use of indegenous natural resources. The National Energy Board provided data which showed to what extent energy use in Canada can be attributed to particular sectors of society and what increases might be expected in energy demand over the next two decades. NEB data indicate that virtually all sectors will anticipate some increase in energy demand to the year 2000, with an overall growth rate of 2.3% per year.[2] As modest as this increase seems, conflicts can and have developed in response to energy demands, and they seem to be centred on the routing and siting of energy facilities.

Mr. E. Kupchanko, Alberta's Assistant Deputy Minister of the Environment, once pointed out that, " the economic and social benefits of resource development must be weighed against the environmental and social costs of such development".[3] It is percisely for this reason that certain individuals and groups feel that they are adversely affected by resource development and actively voice their opposition. These parties are often not willing to accept the benefits of development, since at the same time they may have tc bear many of the social and environmental costs.

Although energy development, including routing and siting, is only one part of overall resource development in Canada, it may well be associated with the greatest number of conflicts. A small study that sought to catagorize dispute activity in Canada, indicates that energy development accounted for more than half of 47 disputes identified over a seven month period,(Figure 1.). A further breakdown indicated that hydro-electric and petro-chemical activities comprised the majority of disputes associated with energy development, (Figure 2.).[4] While this study is neither conclusive or comprehensive, it serves to illustrate the degree to which conflicts arise from resource developments, particularily energy related activities.

Presently, most energy-environment disputes are dealt with through regulatory agencies or government departments. Socio-economic and environmental impact assessments and variations of public participation are used to reach decisions on whether to approve a project, where the activity will be located and what mitigating measures may be employed. While the use of submissions from the public at regulatory hearings can offer valuable input, it is viewed by some as an ineffective way to judge the merits of a particular project. While the project proponent may spend vast amounts of money and employ experts to attest to the need and desirability of the project, private as well as public interest groups and individuals often do not possess the financial or material resources to adequately respond before hearings.[5] In addition, regulatory hearings and tribunals can often be very formal and lengthy. Individuals with little experience in formal proceedings are often caught up in situations where acrimony and animus are exacerbated and where win-lose outcomes can be the end result. On rare occasions, environmental and public interest groups will argue their case in a court of law, but the same formal standards apply and the financial risks can be far greater. The search for new methods of resolving natural resource disputes has led to the formulation of an emerging field called, Environmental Conflict Management. Developed in the United States in the early 1970's, labour-management dispute resolution techniques have been successfully applied to natural resource conflicts, including energy-environment disputes.

New Techniques for Resolving Energy-Environment Disputes

When the words " conflict " or " dispute " are mentioned, many of us consider the words in the negative context. However, conflicts can be positive forces in bringing about productive change. One has only to examine the civil rights movement in the 60's and 70's to observe that great social changes and gains were born from conflict situations. Environmental disputes on the other hand are very complicated and therefore it is difficult to engage in productive problem solving involving many competing interests.[6] It is difficult, but not impossible, as case studies in the United States have shown. Given the diversity of environmental disputes, a number of procedures have developed which attempt to resolve conflicts in a variety of ways. It is important to point out that these procedures are intended to:[7]

1. Make productive use of conflict.
2. Create an opportunity for parties to exchange information.
3. Create an opportunity for parties to develope creative new alternatives that increase the choices available.
4. Reach mutually agreed upon decisions.

These procedures are not intended to:

1. Suppress or avoid conflict.
2. Co-opt the opposition.
3. Convince people to change their values or principles.
4. Get people to like each other.

Gail Bingham, of the Conservation Foundation (Washington, D.C.), has outlined several different methods of dispute resolution which have been adapted and are outlined below:[8]

Negotiation: Broadly defined, it is a process where parties with conflicting interests deal directly with each other in order to reach a mutually agreed upon decision. When parties negotiate in good faith, it is implied that they have the intention and ability to implement their agreements and that the representatives are able to speak for their constituents.

Mediation: Is the assistance of a neutral, " third party ", in a negotiation process. This process is used most often when a dispute is fully developed, i.e., when the parties can be clearly identified, the issues have been defined, the parties have fairly well formulated positions on the issues, and there is a general recognition that no single group or organization can achieve its objectives unilaterally without high costs. The mediator has no stake in the outcome and has no authority to impose a settlement.

Conciliation: Is a process where a neutral third party attempts to reduce the tension and hostility among disputants, in order to open or reopen channels of communication and to establish a dispute resolution process.

Joint Problem Solving: Is used frequently after a dispute has emerged, but before groups have formed strongly opposing positions. It is most effective when used by groups that have similar objectives and/or that have an interdependent relationship. Joint problem solving draws more upon planning processes and group dynamics than upon negotiation. The objectives of a joint problem solving process are to define the issues, reach agreement on a definition of the problem, analyze the problem, generate alternative solutions, evaluate these solutions, and reach a decision. In contrast with negotiation, participants are not encouraged to develope seperate positions from which to bargain, but are assisted as a group to build consensus at each step in the process. Participants usually represent their own views rather than their organization's; and agreements are informal, depending for their implementation on the breadth of their acceptability.

Facilitation: Is the assistance of a netural third party to a joint problem solving process. There are many styles of facilitation, but generally facilitators design and conduct meetings in order to help participants through a joint problem solving process.

Policy Dialogue: Is the application of negotiation and joint problem solving techniques to issues of national environmental policy. It is a small group process where traditional adversaries on public policy issues meet to reason together, seeking areas of agreement and clarification of their differences.

Regulatory Negotiation: Is an extension of policy dialogue and negotiation to the official rulemaking process of regulatory agencies. Representatives of the major interests in a proposed new regulation or change in regulations are invited to participate in the negotiation process and the regulatory agency designates a senior official as negotiator for the agency. The product of the negotiation, if successful, is published in the federal register as a proposed rule, which then goes through normal notice and comment rulemaking.

Environmental Mediation

The dispute resolution process of mediation is selected for further discussion because of its wide use in the U.S. and its use once in a Canadian environmental conflict.

The Institute for Environmental Mediation, based in Seattle, Washington, defines the mediation process as:[9]

> " a voluntary process in which those involved in a dispute jointly explore and reconcile their differences. The mediator has no authority to impose a settlement. His or her strength lies in the ability to assist the parties in settling their own differences. The mediated dispute is settled when the parties themselves reach what they consider to be a workable solution. "

An MIT study identified nine steps toward dispute resolution that a mediator might employ:[10]

1. Identify all the parties that have a stake in the outcome.
2. Ensure that each interest group is adequately represented.
3. Identify the key issues and narrow the agenda to points of conflict.
4. Generate a sufficent number of alternatives.
5. Agree on boundary and time horizons.
6. Weigh, scale and amalgamate judgements about impacts.
7. Identify possible compensatory action.
8. Implement the bargains that are made.
9. Hold the parties to their agreement.

The Institute for Environmental Mediation identifies four seperate phases involved in environmental mediation and describe the possible action that the mediator or parties may take at each phase:[11]

Phases	Possible Action Taken
Exploration:	
-mediator is approached by interested third party or by the parties in dispute. -informal exploration of the situation; who are the relevant actors, current situation, relevant issues. -determine the history of the dispute. -contact made of organizations and agencies outside the present dispute. -informal discussions with parties about possible negotiation procedures.	-a disengagement by the mediator or parties, or both, if either considers mediation inappropriate. -agreement from the parties for further discussions on how mediation may be of assistance.
Process Design:	
-parties are informed about the specific manner in which mediation can be used. -procedural points are discussed. -a public announcement of " good faith " negotiation is made.	-disengagement by the mediator or parties. -decision by parties to resolve the dispute without mediation. -commitment by parties to engage in face to face negotiation.
Negotiation/Mediation:	
-skills employed, i.e. communication, interpretation, data gathering, idea generation, educator, realist, confidant, secretary. -coordinates actions of organizations and agencies. -formation of " caucuses ", to explore alternatives to data sources, etc.	-disengagement of the mediator and/or the mediation process. -unanimous agreement on the resolution of the dispute.
Implementation:	
-mediator facilitates continuing party interaction. -ensures that all agreements are binding. -plans for the unforeseen problems that may interrupt the agreement.	-withdrawal by the mediator from the dispute.

There are a number of organizations in the United States that offer mediation services in cases of environmental disputes. The procedures they use vary according to the nature of the dispute and the degree to which the parties are willing to negotiate on key issues.[12] Perhaps the two most important aspects of a successful environmental mediation are the inclusion of all the affected parties (since parties that are excluded from the negotiation may resort to legal action to prevent the implementation of an agreement), and the inclusion of regulatory and government agencies, (either as parties to the negotiation or as sanctioners' of the mediation attempt), since any negotiated agreement will probably have to have government approval for its implementation.

Case Studies

There are few cases of environmental mediation in Canada that can be used to describe how the process worked. Currently, there is an environmental mediation attempt being undertaken near Lake Simcoe involving the siting of a landfill. The only other mediation attempt took place in 1976 in Northern Manitoba and involved compensation paid to Indian Bands due to flooding from hydro-electric dams.

The Northern Flood Agreement - Manitoba

During the 1960's the Federal Government of Canada and the Provincial Government of Manitoba agreed to allow Manitoba Hydro to divert the waters of the Churchill River into the Nelson River. This action allowed for the possible construction of up to 10 hydro-electric generating stations in order to meet the electrical needs of Manitobans and to provide power exports to other Provinces and the United States.[13] The project caused the flooding of over 100,000 square miles of land, rivers and lakes the majority of which were on land used by Indian communities for traditional hunting, trapping and gathering activities. Faced with the erosin of their traditional lifestyle and major means of subsistence, five Indian communities joined forces and formed an organization known as the Northern Flood Committee. The NFC was not in total opposition to the project, but wished to ensure that benefits from the project would take place and that adequate compensation was forthcoming.[14] Attempts to gain agreement on the use of a neutral arbitrator failed because the NFC were not prepared to give a third party the power to decide for them their rights to use of land and resources, and the extent and nature of compensation to be paid. On the advice of legal counsel for the NFC , a mediator, Mr. Leon Mitchell, was retained to explore with the parties the option of mediation.

On February 13, 1976 the parties to the dispute entered into a mediation agreement which contained the following points:[15]

1. A broad statement that adverse effects to the Indians may result from the diversion and the rise and fall of water levels for the purpose of developing hydro-electric generating facilities.

2. A mediator was appointed to mediate the issues.

3. The mediator was empowered to:

    a. convene meetings after a minimum 48 hours notice;
    b. propose further studies and possible solutions to the issues;
    c. meet separately with any one or more of the parties to discuss their positions;
    d. adjourn or postpone meetings for a mazimum of one week.

4. The parties undertook at the request of the mediator:

    a. to make available to one another or the mediator their experts.
    b. to make available to one another or the mediator documents but not confidential information.

5. The issues to be negotiated were defined as: compensation for damages, monetary or other forms and remedial measures arising out of or attributable to the hydro project.

6. The parties undertook to negotiate in good faith and conclude an agreement in 2 months or such later date as may be agreed to by the parties.

7. The mediator was permitted at his discretion to make public a report presenting his analysis of the outstanding issues and the reasons for failing to reach a settlement.

8. The participation in these negotiations was agreed to be without prejudice to any of the rights at law by any party.

In 1977 the parties reached agreement on the issues of dispute which included: compensation from land flooded in the form of other land rather than money, granting the Indians the right to select land for development to broaden their economic resource basin opportunity and provided for Indian participation in a wildlife resource advisory council to manage the resources.[16]

Although problems developed in the implementation of the agreement, all parties generally recognized the utility of the mediation process in obtaining an agreement and supported the process as an alternative to possibly costly and lenthy litigation.[1]

Homestake Pitch Mine Dispute - Colorado

In 1981 the Institute for Environmental Mediation, based in Seattle, was approached by the Homestake Mining Company and a coalition of environmental organizations from Colorado to help resolve a dispute over the proposed construction of an open-pit uranium mine and mill near Gunnison. The mining company and the environmental coalition were the principal parties, but also involved were the Colorado Department of Natural Resources, the Colorado Department of Health and the U.S. Forest Service. The parties came to the conclusion that neither wanted to persue a course of litigation, where the outcome was uncertain and where delays to the project through appeals might be costly.

The substantive aspects of the dispute centred on reclamation of the open-pit mine with emphasis on maintenance of water quality during and after the mining operations, backfilling, revegetation and mitigation of wildlife and fishery impacts. It was the position of the coalition that these issues were not properly addressed in the EIS and were the reason for their opposition to the project. The uranium mill was not dealt with in the mediation because the coalition felt that the technical issues were too complex and the environmental impacts could not be mitigated and therefore negotiations on the licencing of the mill was deferred.[18]

Involved in the mediation were four joint meetings with experts to exchange information and consider data. In addition there were at least three negotiation sessions, briefings of interested Federal and State agencies on the terms of the settlement and a joint press conference. The form of the agreement was in three parts:[19]

1. A Statement of Understanding stipulated that permit revisions regarding water quality maintenance and revegetation be jointly presented to the State.
2. A Mediation Agreement which established cooperative programs and company efforts in dealing with water quality, revegetation, wildlife and fisheries.
3. A Covenant Not to Sue that was formally ratified by Company headquarters and the Board of environmental organizations.
4. A Joint Press Release that was negotiated by the parties.

Although the mediation took approximately 16 months to complete, the parties generally felt that the time taken to reach agreement was much less than what might have been expected if they had chosen litigation. One of the problems encountered during the mediation was the withdrawl of one of the coalition's constituents. An anti-nuclear group felt that they could not support the actions of the uranium mine on ethical grounds. This action could have placed any agreement into jeopardy, since the disaffected party might have resorted to litigation. So far the anti-nuclear group has not done so.

One organization, based in Canada and the United States, has identified a number of energy projects that have the potential to cause transboundary environmental disputes, (Figure 3.). Environmental Mediation International Inc. has investigated these projects to determine if mediation could be used and if the parties are willing to explore alternative approaches to dispute resolution.[20]

Environmental Mediation and the Regulatory Process

At a recent workshop in Banff, (Conflict Resolution in Resource Management), the question was posed of how dispute resolution techniques such as mediation might be used in the Canadian context. The majority of the participants were representatives of various Provincial and Federal government departments and it was felt that mediation might be most appropriate at the regulatory level of environmental decision making.[21] Since many agencies already engage in ad hoc negotiations with various parties on the implementation of a rule or regulation, the move to using some of the methods described in this paper does not seem to be insurmountable. What is lacking is the expertise and familiarity with these alternative processes in order to assure all parties that mediation might be an effective alternative.

The National Energy Board of Canada is an agency that has come under a great deal of scrutiny since many of the projects it reviews involves large amounts of capital expenditure and the proposed energy projects may have significant and widespread social and environmental consequences. The hearings into the Arctic Pilot Project (now shelved), to ship liquid natural gas from the arctic to Eastern Canada, involved lengthy and probably costly arguments between the lawyers for the project's proponents and those of the Inuit associations opposing the project. If alternative dispute resolution mechanisms had been in place, it might have been possible for the parties to explore and reconcile some or all of their differences prior to attending the hearings.

Along with the general increase in environmental awareness of the late 60's and early 70's, it became apparent to the National Energy Board that environmental groups could potentially disrupt or delay the Board's regulatory proceedings.[22] Inclusion of public interest and environmental groups at the hearings certainly gave a more balanced consideration of the issues, but many intervenors found that the formality of the proceedings, the necessity of using legal representatives and technical experts, as well as cost incurred in obtaining transcripts of the hearing became prohibitive.[23] Specific techniques that would address the issue of involving the public in a more direct and fair manner have been discussed, but to date none have been developed.

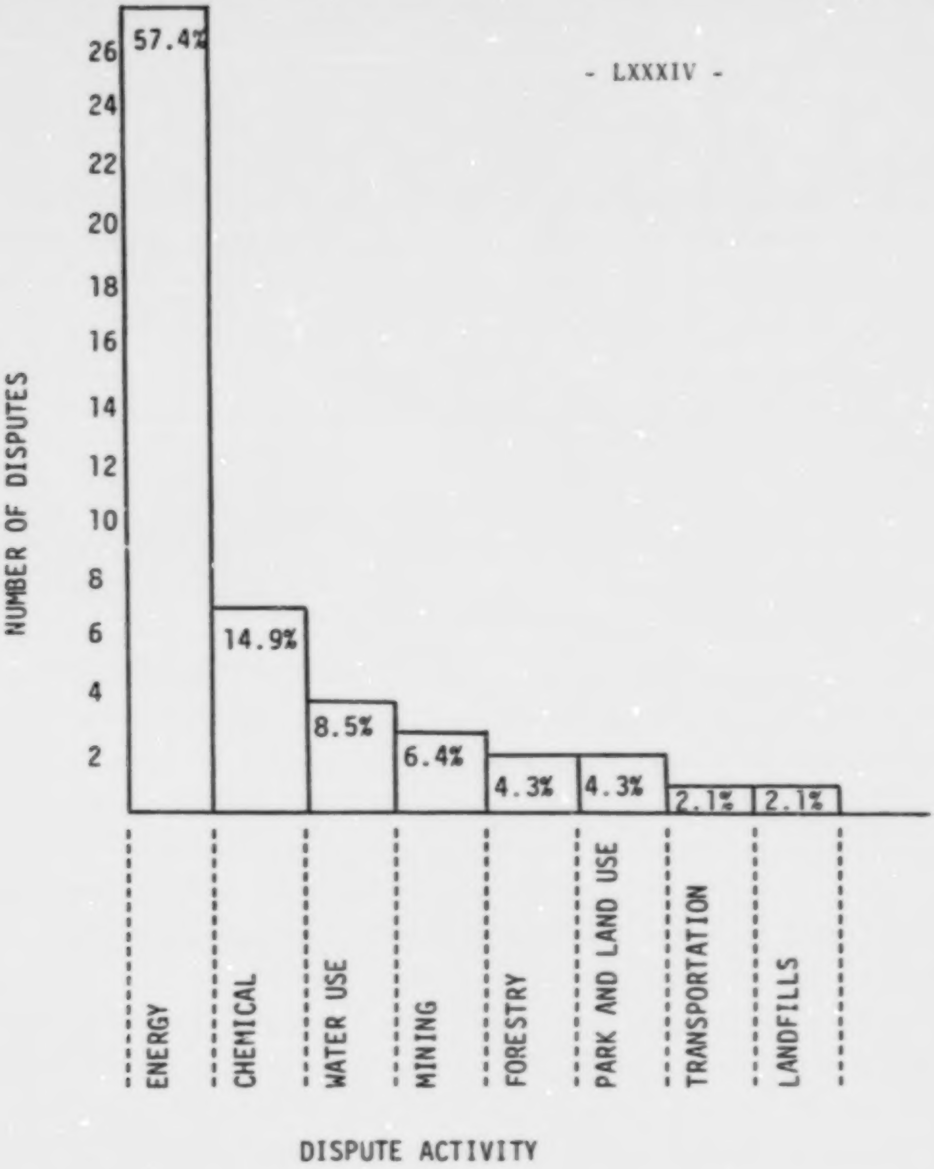
It would appear that even energy related industries would like to see a better defined process involving the public in environmental regulation of the oil and gas development activities.[24] As it stands now, many energy industries feel uncertain about the legal basis and the role the public plays in approval of energy projects. It may be that Industry would welcome the opportunity to negotiate directly with affected parties prior to, or in conjunction with, various environmental regulatory hearings.

Conclusion

Axelrod (1981), points out that," There need not be conflict between energy usage and the environment if a new conception of the future emerges." He notes that the lack of comprehensiveness in policy making, that is found in energy-environment problems, is characteristic of a political system that indulges in crisis decision making while postponing problem solving.[25] Smil (1974), goes one step further in suggesting that, " Bargaining, mediation and conciliation are tedious processes, but until we have at our disposal cheap and nonpolluting energy production technologies, these actions are absolutely necessary both to prevent detrimental environmental changes and to secure the necessary flow of energy. "[26]

There have been initiatives in Canada which offer hope that environmental mediation and other conflict management techniques will be used. Two very good reports, one by Haussmann in 1982, and another to be released soon by the Canadian Environmental Law Association, provide information that prospective parties to a mediation might find helpful. In addition, there have been two conferences in Canada, (in Ottawa and in Nanaimo), that have provided the opportunity for dialogue between environmental, industrial and government representatives on the merits of environmental mediation. Perhaps the most recent discussion of environmental mediation is the most interesting; The March 1984 Ontario Speech From the Throne concedes that, " in some cases mediation may be a more sensible means of resolving disputes than existing administrative or judicial processes. Consequently, experimental mediation procedures will be initiated with the Environmental Assessment Board. "[27]

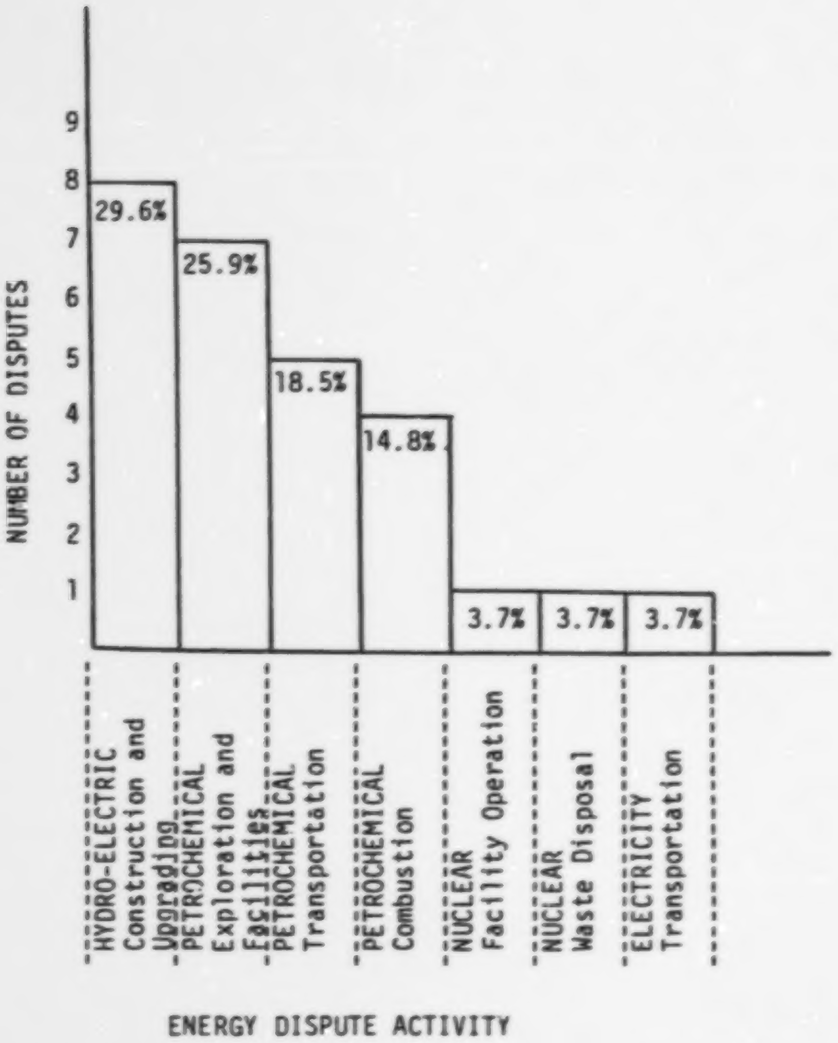
This paper does not intend to offer environmental mediation as a panacea for all environmental disputes. Administrative and judicial processes as well as existing public participatory mechanisms will continue to be used in sound environmental decision making. However, new techniques that seek to resolve conflicts should be considered when siting and routing energy facilities.



ENVIRONMENTAL DISPUTES

Disputes listed are categorized by type of activity which led to dispute.
Data was obtained by analysis of news articles and press releases distributed by Environment Canada's Media Monitoring Service.
Data was compiled over a 7 month period, from November 1981 to May 1982.
Criteria for selection of dispute:
1) clearly defined issue
2) clearly identified - proponents and opponents
3) action oriented
    - legal proceedings
    - regulatory hearings
    - referrendum
    - public protest - media
    - appeal to elected representatives and government

Figure 1.

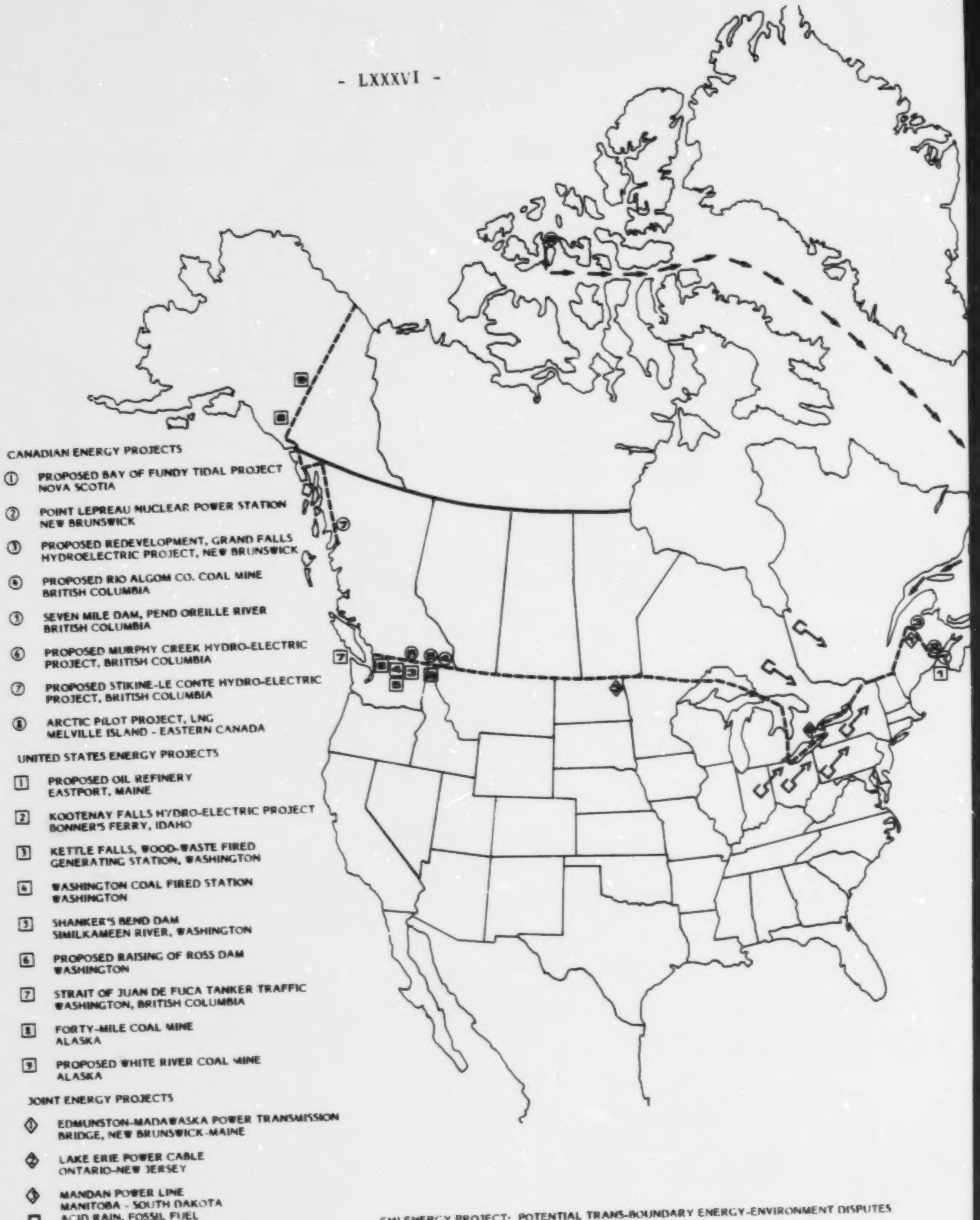


ENERGY RELATED ENVIRONMENTAL DISPUTES

Disputes listed are categorized by type of activity which led to dispute.
Data was obtained by analysis of news articles and press releases distributed by Environment Canada's Media Monitoring Service.
Data was compiled over a 7 month period, from November 1981 to May 1982.

Criteria for selection of dispute:
1) clearly defined issue
2) clearly identified - proponents and opponents
3) action oriented
    - legal proceedings
    - regulatory hearings
    - referrendum
    - public protest - media
    - appeal to elected representatives and government

Figure 2.


CANADIAN ENERGY PROJECTS
① PROPOSED BAY OF FUNDY TIDAL PROJECT NOVA SCOTIA
② POINT LEPREAU NUCLEAR POWER STATION NEW BRUNSWICK
③ PROPOSED REDEVELOPMENT, GRAND FALLS HYDROELECTRIC PROJECT, NEW BRUNSWICK
④ PROPOSED RIO ALGOM CO. COAL MINE BRITISH COLUMBIA
⑤ SEVEN MILE DAM, PEND OREILLE RIVER BRITISH COLUMBIA
⑥ PROPOSED MURPHY CREEK HYDRO-ELECTRIC PROJECT, BRITISH COLUMBIA
⑦ PROPOSED STIKINE-LE CONTE HYDRO-ELECTRIC PROJECT, BRITISH COLUMBIA
⑧ ARCTIC PILOT PROJECT, LNG MELVILLE ISLAND - EASTERN CANADA
UNITED STATES ENERGY PROJECTS
1 PROPOSED OIL REFINERY EASTPORT, MAINE
2 KOOTENAY FALLS HYDRO-ELECTRIC PROJECT BONNER'S FERRY, IDAHO
3 KETTLE FALLS, WOOD-WASTE FIRED GENERATING STATION, WASHINGTON
4 WASHINGTON COAL FIRED STATION WASHINGTON
5 SHANKER'S BEND DAM SIMILKAMEEN RIVER, WASHINGTON
6 PROPOSED RAISING OF ROSS DAM WASHINGTON
7 STRAIT OF JUAN DE FUCA TANKER TRAFFIC WASHINGTON, BRITISH COLUMBIA
8 FORTY-MILE COAL MINE ALASKA
9 PROPOSED WHITE RIVER COAL MINE ALASKA
JOINT ENERGY PROJECTS
1 EDMUNSTON-MADAWASKA POWER TRANSMISSION BRIDGE, NEW BRUNSWICK-MAINE
2 LAKE ERIE POWER CABLE ONTARIO-NEW JERSEY
3 MANDAN POWER LINE MANITOBA - SOUTH DAKOTA
ACID RAIN, FOSSIL FUEL THERMAL POWER PLANTS

EMI ENERGY PROJECT: POTENTIAL TRANS-BOUNDARY ENERGY-ENVIRONMENT DISPUTES

Figure 3.

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4. The author recognizes that these data may not be conclusive and that additional information sources may be necessary to verify the results.

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20. Figure 3, was constructed in response to a survey sent to Provincial, State and Federal agencies that could identify environmental problems associated with energy activities, and that had the potential to become transboundary conflicts. Since the completion of the survey, some of the energy projects listed are now defunct. The APP, Lake Erie Power Cable and Mandan Power Line have been shelved. The dispute over the Ross Dam has been resolved through negotiation.

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WORKSHOP SUMMARY

Session III "Regulation, Public Interest and Decision-Making"

Summary of Workshop Discussion

C. Hunt

"Regulation, Public Interest and Decision-Making"

I. Issues of Public Participation and Interest

A. Principles of Public Participation

There was general consensus that while public involvement in site/route selection may not be strictly necessary in all cases, it is desirable, since it can help improve a project and its public acceptability.

Approaches to public involvement in any proposed project should be addressed by the proponent in an organized fashion very early in the planning stages, and should take into account both the internal objectives of the proponent and the external needs of the public.

There was also general consensus on the need to involve the public at an early stage. Exactly when to do so is problematic, however. With apologies to the story of Goldilocks and The Three Bears, it should be not too early, and not too late, when it is "just right". One way to deal with the complicated question of timing is to approach the project in "stages". The public should at least be informed at the feasibility study stage, and the information flow should continue as planning proceeds.

One matter that proved somewhat contentious was whether or not there is a need to legislate a minimum standard for public participation in the approvals process. The general view seems to be that while the principle of public participation might usefully be legislated, the content should not because there is a need for flexibility in the content depending upon a host of factors. Such factors include: the size, nature, location and expected impact of the project; the size and level of interest of the affected publics; the previous record and past experience of the proponent; and the stage of the proponent's plans (to mention just a few). The principle of public participation should be supplemented by policy statements and guidelines that set out expectations in more detail.

One group suggested the following model concerning public participation for inclusion in legislation:

> The affected public(s) shall be afforded the opportunity to enter their concerns and opinions (which shall be documented) into the project process preceding each major decision point such as:
>
> - need vs. no action
> - design of study
> - development of environmental criteria
> - development of alternatives
> - identification of preferred routes or sites

- selection of mitigative measures
- identification of centreline.

B. Methods of Public Participation

While the appropriate method will depend on a range of project-specific factors (such as those outlined above), the groups outlined a wide variety of possible methods, including:

- newsletters, reports, notice, flyers
- phone "hot" lines
- opinion surveys
- public advisory/citizen committees
- information centres, such as libraries and open houses
- public meetings in local areas
- regular community contacts - networking

There was considerable discussion of the concept of mediation. It was generally felt that this method was of limited usefulness, because it could only be employed in those cases where a small number of parties are affected. Moreover, there is not usually a common party to represent the public interest. Finally, it could tend to extend the time frame for project approvals, and thus may be counterproductive.

.../4

C. Means of Promoting the Public Interest

Two impediments to the public interest were identified in the discussions.

The first is the fact that there is often considerable overlap/duplication in both regulations and review processes. These can occur as between the provincial and federal governments and also within both levels of government. Overlap and duplication are wasteful because they result in excessive costs, in ordinate study requirements and delays in decision-making.

Three main solutions to this problem were identified. The first is the "single window" approach examples of which can be found in Alberta's Energy Resources Conservation Board and Ontario's Consolidated Hearings Process. Another alternative is co-ordination of review processes, at the interjurisdictional level. One example is the federal - Nova Scotia review of the Venture Gas Project. A third approach would be to have agreement that a decision made by one tribunal would be binding on all the others.

Another potential impediment to promoting the public interest is industry's reluctance to share "confidential" information with the public. This can occur when such information could impair a company's competitive position, or when policies have been arrived at and/or based upon internal corporate strategy.

Requirements to disclose such information should depend in part upon the particular stage of the project, and there should be overall equality of treatment as between different companies. However, there was apparent consensus that information relating to compliance (both the raw data and resulting analyses) should be made available to the public.

There was discussion of the extent to which and circumstances in which compensation might reasonably be considered an alternative to mitigation. Generally, compensation should be considered only as a last resort, and not when a unique or scarce resource is at issue. Compensation to an individual, it was pointed out, does not necessarily solve environmental problems; moreover, economics should not be the sole criteria for determining when compensation is appropriate, as there are other values that may be more important.

With these limitations, compensation may be appropriate for residual problems, following mitigation. Compensation works best when losses are quantifiable, or when losses can be repaid in kind.

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II. Appropriate Roles and Responsibilities for Proponents and Regulators

A. Proponents

The proponent bears the main responsibility for facilitating public involvement in a project, particularly in the earlier stages. It also has an overall obligation to demonstrate that a broad range of alternatives have been considered in the planning stage (public involvement early in this process can help to avoid subsequent conflict). Industry needs to consider alternative techniques of implementing a particular project.

Industry also has major responsibility in the area of monitoring, especially to ensure compliance with government requirements. When impacts are uncertain, both industry and government ought to share monitoring obligations. But regardless of the industry/government division of labour in relation to monitoring, there is also a role for the public to play. The public's reaction to a project after the construction phase could usefully be monitored, and the public itself may also play a useful part in monitoring activities. In any event, as indicated earlier, the public should always have access to the results of monitoring.

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B. Government/Regulators

Although the role of government and regulators is not necessarily greater than that of the proponent, it may take a little longer to describe.

Just as the proponent has a responsibility to promote and facilitate public involvement at an early stage of its project, regulators need to be sure that the public is well-informed as to the nature and timing of public review processes, methods of intervention, etc. Regulators also have a watch-dog role in relation to overseeing the definition of the affected "publics", and the nature and adequacy of the public - involvement mechanisms being employed by the proponent. They should have the responsibility to determine the content, nature and timing of the notice given by the proponent to the public, particularly in the later, post-feasibility stages. In relation to the feasibility stage, however, government has another role, namely to ensure that the proponent takes a broad overview.

Although no clear consensus emerged from the Workshops on the question of who should bear the cost of public participation exercises, there was a measure of agreement that a key part must be played by an independent third party, notably the regulator. At times, it may be appropriate for costs to be shared between the regulator and the proponent.

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But in any event clear criteria and limits should be established and applied by the regulating agency. If funding is provided prior to public participation in a review process, however, the proponent should not be required to contribute until such time as the regulator has made a determination as to the effectiveness of the public's intervention.

Finally, government has a major role to play in monitoring. Monitoring should not be open-ended; but where it is intended to evaluate impact prediction, the task should fall primarily to government. It is also government's main obligation when monitoring is required to produce or improve standards. In any case, it is up to government to see that the public is involved in monitoring.

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